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Heavy Specifying at Close of a Wonderful Year

Pig Iron Market Strong and Sales Large For Holiday Period—Structural Orders Placed in Chicago District

Cheerful sentiment prevailed at the beginning of last year, for there were encouraging indications that a change for the better was setting in after prolonged depression. Early in the year, the hopes of the most optimistic were realized, and as the months passed, the volume of business far exceeded expectations, placing the year in the lead of all periods of great activity. While a large part of the orders was taken at low prices, profits for the year have been very comfortable. Sound conservatism of important interests prevented the too rapid advancing of quotations. The new year opens with heavy specifying on contracts, buying as active as could possibly be expected after the very heavy ordering of past months and with deliveries of such important products as plates, bars and structural shapes deferred into the third quarter of the new year except on the limited tonnages obtainable at premium prices from the few companies whose contract obligations are not such as to keep their mills fully employed up to at least the first of July. In spite of what were considered the large additions to iron and steel making capacity, the country's demands have far exceeded the greatest possible production. Blast furnace construction has not kept pace with the rate of earlier years.

Pig Iron

The most important transaction of the past week in pig iron was the purchase of 50,000 tons of basic and 20,000 tons of Bessemer by the Youngstown Sheet & Tube Co. from the Ohio Iron & Steel Co., at prevailing prices. While in other centers no very large tonnages have been placed, the aggregate of moderate tonnages is much larger than that usually placed during the holiday period. The total in the New York district booked since Christmas is about 50,000 tons.

Structural Material

The structural contracts entered in the Chicago district during the last week of the year amounted to 25,475 tons, including 22,000 tons taken by the American Bridge Co. for the construction of the Duluth, Messabe & Northern Railroad Co.'s new ore dock at Duluth. Deliveries of structural material are being further extended and higher premiums are being asked for anything approaching prompt delivery. The Steel Corporation is understood to have purchased from 15,000 to 20,000 tons of billets from a southern maker for its Pencoyd plant.

Railroad Buying

Buying by the railroads continues at a very active rate. Orders for rails placed within a few days amount to fully 100,000 tons, including 30,000 tons for the New York Central. A number of additional orders have been placed for cars. In the Chicago district, some car builders are not able to give delivery before Jan. 1, 1914.

Heavy Specifying

Specifying has been very heavy during the past few days on contracts expiring with the year. Consumers frequently have specified beyond their contracts and sometimes have agreed to pay prevailing prices on the excess tonnage, these prices often being much higher than those of the contracts. Users of steel bars are finding difficulty in placing contracts, as leading companies are not ready to consider any orders for last half.

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Year of Great Prosperity in Pittsburgh District

Production at a Tremendous Rate, But Falls Far Behind Demand — Steady But Moderate Advance in Prices

By C F Williams

NINETEEN hundred and twelve always will be regarded as one of the satisfactory years in the iron and steel industry in the United States. At no time during the 12 months just ended were prices considered high and yet, manufacturers of all lines of finished products were able to enjoy fairly good profits. The policy of the leading interest and the most important independent mills was to maintain quotations on as low a basis as possible. This influence, it is believed, prevented a runaway market the latter part of the year, when anxious consumers seemed willing to pay almost any price manufacturers cared to ask.

In many respects, 1912 was the opposite of the preceding 12 months. In 1911, prices gradually declined; in 1912, quotations steadily advanced, especially during the last six months of the year.

Production of nearly all lines of finished iron and steel products was as great, if not greater, in 1912 than in any other year in the history of the trade. This is especially true regarding the manufacture of sheets and tin plate in which all previous records for production were broken. The production of pig iron also exceeded that of any other year, and similar records were established in several other branches of the trade.

Iron and steel manufacturing interests in all parts of the country enter the new year under the most auspicious conditions. Nearly all the mills, at the close of 1912, had sufficient tonnage on their books to necessitate maximum operation through the first six months of the new year, and many of the steel companies took contracts through the entire year of 1913 for specific work.

The labor shortage and the acute scarcity of semi-finished steel products the last five months of the year naturally curtailed production to a great extent. Many of the mills were unable to operate within 15 per cent of desired capacity.

The following shows advances in prices the first 11 months of the year: Bessemer pig iron, $3.25; basic pig iron, $4.10; No. 2 foundry, $4.50; malleable, $4.60; Bessemer billets, $7.50; plates, $8 (considering 1.50c the maximum price); steel bars, $6; bar iron, $8; No. 10 blue annealed sheets, $6; No. 28 black, $10; No. 28 galvanized, $12; tin plate, $6; wire products, $4; hoops, $5; bands, $6; heavy melting steel, $3.75.

Minimum Monthly Prices Pittsburgh Market 1912

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Bessemer	$15.15	$15.00	$15.02	$15.15	$15.15	$15.15	$15.15	$15.43	$15.93	$17.75	$18.05	$18.15
Basic	13.28	13.30	13.44	14.00	13.00	13.41	14.40	14.85	15.33	16.95	17.12	17.40
No. 2 foundry	13.90	14.00	14.08	14.25	14.20	14.21	14.40	14.87	15.40	17.05	18.21	18.40
Gray forge	13.65	13.60	13.46	13.77	13.95	13.96	13.96	14.32	14.60	16.15	16.90	16.90
Malleable	13.65	13.80	13.77	14.00	14.15	14.15	14.27	14.80	15.21	16.95	18.15	18.15
Ferro manganese, Baltimore	42.95	41.39	41.00	43.62	47.50	48.50	48.87	52.20	55.75	58.30	60.62	65.00
Bessemer billets	20.00	20.00	19.88	20.00	21.10	21.88	22.25	22.40	23.75	25.70	26.75	27.00
Rails	1.25c	1.25c	1.25c	1.25c	1.25c	1.25c	1.25c	1.25c	1.25c	1.25c	1.25c	1.25c
Structural	1.15c	1.15c	1.15c	1.17c	1.25c	1.25c	1.30c	1.37c	1.43c	1.43c	1.45c	1.45c
Plates	1.15c	1.12c	1.12c	1.16c	1.25c	1.26c	1.30c	1.30c	1.37c	1.43c	1.45c	1.45c
Steel bars	1.15c	1.13c	1.12c	1.16c	1.20c	1.21c	1.25c	1.27c	1.32c	1.38c	1.40c	1.40c
Iron bars	1.34c	1.33c	1.30c	1.30c	1.30c	1.31c	1.37c	1.40c	1.47c	1.53c	1.69c	1.70c
Sheets, black	1.90c	1.86c	1.80c	1.82c	1.94c	1.95c	1.97c	2.05c	2.10c	2.21c	2.25c	2.25c
Sheets, galvanized	2.90c	2.87c	2.82c	2.87c	2.99c	3.00c	3.04c	3.15c	3.22c	3.36c	3.40c	3.40c
Tin plate	$3.40	$3.37	$3.32	$3.35	$3.38	$3.40	$3.45	$3.50	$3.57	$3.60	$3.60	$3.60
Wire nails	1.56c	1.60c	1.60c	1.59c	1.60c	1.57c	1.60c	1.63c	1.70c	1.70c	1.70c	1.70c
Hoops	1.30c	1.25c	1.25c	1.25c	1.25c	1.25c	1.35c	1.40c	1.41c	1.43c	1.50c	1.50c
Heavy melting	$12.38	$12.30	$12.75	$12.87	$13.25	$13.31	$13.50	$13.55	$13.94	$15.45	$15.00	$14.34

Pig Iron

Pig iron manufacturers enjoyed a remarkably good year. It is true that blast furnace interests in other territories were able to obtain higher prices than those with stacks in the so-called Pittsburgh and valley districts, but in no section of the country was the market on a sounder basis.

Despite numerous heavy buying movements, prices, especially for steel-making iron, did not advance so rapidly as many in the trade expected. Bessemer pig iron, for instance, remained almost stationary the first half of the year, at the end of which period it began to advance gradually. What has been said of Bessemer applies in a great measure to other grades of pig iron.

Almost every serviceable blast furnace in the district was operating at the end of the year, when an almost unprecedented shortage of steel-making iron was being experienced. The scarcity, or rather the high price of coke, caused embarrassment to a number of the merchant blast furnace owners.

The prosperous condition of the general iron and steel market resulted in an unusually heavy, and almost constant, demand for iron the last six months of the year. The Youngstown Sheet & Tube Co., Youngstown, O.; the Cambria Steel Co., Johnstown, Pa.; the Republic Iron & Steel Co., Youngstown, O.; the Jones & Laughlin Steel Co., the Pittsburgh Steel Co., the Allegheny Steel Co., the Carbon Steel Co., all of Pittsburgh, the several sanitary manufacturing interests and the car builders in this district played a rather conspicuous part in the heavy buying movements of the year.

Bessemer pig iron, the first six weeks of the year, was quoted at $14.25, valley, or $15.15, Pittsburgh, at the end of which time it declined 25 cents. The $14, valley, quotation

continued for five weeks and then, for a period of 19 consecutive weeks, the minimum price of this particular grade was $14.25, valley furnaces. Bessemer gradually advanced from the early part of August until the middle of November, when it reached the $17.25, valley, mark.

Prices For Basic

Basic pig iron was subject to numerous fluctuations during the entire year. During the first two months, basic sold at approximately $12.40, valley. Early in March this grade began to advance and by the middle of the month was firmly established on a $13, valley, basis. During the last two weeks of April, basic sold at $13.25, valley, but prices began to soften in May and by the end of that month basic was represented by a $13, valley, quotation. In June, basic began to reflect strength, and gradual advances were experienced until the $16.50, valley mark, was reached in November.

Foundry and malleable fluctuated considerably, showing both strength and weakness, the first six months of the year. In October and November, both grades were quoted higher than Bessemer, when under normal conditions they are generally quoted $1 a ton less than Bessemer pig iron. Gray forge did not show particular strength until at the close of the first half.

Early in the year, the Pittsburgh Steel Co. closed for 15,000 tons of standard basic, for shipment to plants at Monessen, at slightly less than $12.50, valley, and a week later this interest obtained 12,000 tons of the same grade at about $12.50, valley.

The Youngstown Sheet & Tube Co., early in March, closed negotiations for 105,000 tons of third quarter Bessemer; the Republic Iron & Steel Co. bought 10,000 tons of Bessemer and the Corporation 25,000 tons of the same grade. These transactions closed in the neighborhood of $14, valley. In May, the Carnegie Steel Co. obtained a 15,000-ton block of prompt basic at $14.50, valley.

Heavy Buying

In the early fall, the Westinghouse Air Brake Co. bought 18,000 tons of foundry and gray forge; the Standard Sanitary Mfg. Co. obtained 13,000 tons of mixed iron; the Youngstown Sheet & Tube Co. closed for about 50,000 tons of Bessemer and 20,000 tons of gray forge, and the Pittsburgh Steel Co. purchased about 15,000 tons of basic. Bessemer involved in these purchases was obtained at about $14, gray forge at $13.25 and foundry at $13.50, all at valley furnaces.

Early in October, the Westinghouse Electric & Mfg. Co. bought 15,000 tons of first and second quarter foundry at $15.50, valley. About a week later, the Cambria Steel Co. closed negotiations for 72,000 tons of basic, Bessemer and foundry iron. The Allegheny Steel Co. obtained 18,000 tons of first half basic the middle of October at $16 and $16.10, valley. The Cambria Steel Co. again figured in the market the first week in November, buying 30,000 tons of Bessemer at $17, valley, and 29,000 tons of basic at $16 and $16.25, valley, for six months shipment, beginning at the time negotiations were closed. The Standard Steel Car Co., a short time previous to Cambria's second large purchase, bought 40,000 tons of basic. The Republic Iron & Steel Co. obtained 24,000 tons of Bessemer and 6,000 tons of basic, paying $17 and $17.15 for the former grade, during the fall buying movement. The Jones & Laughlin Steel Co. bought 42,000 tons of Bessemer and 15,000 tons of basic the latter part of November, paying $17 and $17.25, valley, and $16 and $16.25, valley, for Bessemer and basic, respectively. The Pittsburgh Steel Co., early in December, bought 5,000 tons of prompt basic at $16.50 and 30,000 tons of first half basic at $16.35, both at valley points. Just before the close of the year, the Youngstown Sheet & Tube Co. closed for about 25,000 tons of Bessemer and 50,000 tons of basic, paying around $17.25 for the Bessemer, and slightly less than $16.50 for the basic.

Plates

One of the most important features of the 1912 market for steel plates was the unusually heavy buying of cars on the part of railroads in all parts of the country. In 1911, when the various railroads purchased in the neighborhood of 136,000 cars of miscellaneous types, many in the trade believed that a similar record would not be established for a half decade or more. It is conservatively estimated, by those in close touch with the car-buying movement, that 235,000 cars were ordered in 1912, or almost 100,000 cars more than were purchased in the preceding 12 months. The heavy buying of cars is believed, by many, to be indicative of continued prosperity in the trade.

All of the car building shops in the country were busily engaged during all of the 12 months just ended, and present orders cannot be filled until well into the second quarter of 1913.

At the opening of the year plates were uniformly quoted at 1.15c, as against 1.40c at the beginning of 1911. Many of the independent mills, early in February, began selling plates at 1.10c, although the leading interest, which was well provided with orders for specific work, refused to shade the 1.15c quotation. Prices began to stiffen early in March and, by the end of that month, quotations were firmly established at 1.20c. On April 22, the Carnegie Steel Co. formally advanced prices $1 a ton and a month later the market began to display almost unprecedented strength. On June 26, the leading interest advanced prices to 1.30c.

Steady Advance

Before the middle of November, plates had been advanced $3 a ton, rather informal advances of $1 a ton each being made. At the close of the year the Carnegie Steel Co.'s maximum quotation was 1.45c. The Jones & Laughlin Steel Co., and several other large independent manufacturers, did not quote steel plates above 1.50c. Other mills refused to shade 1.55c and 1.60c for forward delivery. As high as 2c was paid for prompt material the last two months of the year, although this figure generally was regarded as a premium, rather than a market price.

Early in March, the Jones & Laughlin Steel Co. received an order for 1,850 tons of plates and rivets for work on the Panama canal, and about a week later the Carnegie Steel Co. took an order for 3,100 tons of plates for a lake passenger steamer. The Pennsylvania system, the New York Central lines, the Bessemer & Lake Erie, and all of the railroads, in fact, figured in rather large car orders during the year.

The market for steel plates showed no weakness the entire 12 months, except during the early part of February, when it was possible to obtain tonnages at 1.10c. In the first six months, steel plates advanced $4 a ton, and during the 11 months they advanced $7 a ton. This spread, it is interesting to note, does not include quotations above 1.45c.

Merchant Bars

Manufacturers of iron and steel bars began the year under fairly auspicious conditions, some of the mills having sufficient tonnage on their books to necessitate maximum operation for 60 days. At the close of the present year, the majority of bar makers had contracted through the first half of 1913, and none of the leading manufacturers was soliciting

(*Continued on page* 112.)

Marvelous Recuperation of a Great Industry

Impressively Illustrated in Eastern Territory—Tremendous Production by Mills and Furnaces—Many New Records Made

By C J Stark

TO SURVEY the year 1912 is to marvel again at the traditional recuperative power of the iron and steel industry of the United States. In the 12 months just passed, the recovery of the industry has spanned from the fag-end of the most demoralized market known in 14 years to a condition of trade far in advance both in productive activity and in general prosperity, of any other year in the history of the country. Characterized by the most unexpected vigor of demand, by unexampled output and by shattered precedents of every order, 1912 takes a singular position in history as embracing the most remarkable trade revival ever known and that, too, in a presidential year.

Once again has the "prince or pauper" regime in the steel industry been exemplified in a pronounced fashion, with the "prince" predominating.

The greatly expanded productive capacity of the country which quietly but steadily had been undergoing establishment during the past several years, felt, for the first time, the pressure of a commensurate demand and broadly was driven into service. The blast furnaces of the country produced better than 29,500,000 tons of pig iron, or about 6,000,000 tons more than in 1911 and more than 2,000,000 tons greater than the previous high record of 27,303,567 tons, in 1910. The steel works of the country crossed the magical 30,000,000-ton mark in ingot and castings output for the first time. The total steel production of the country will probably be not less than 31,000,000 tons, compared with 26,094,919 tons in 1910. In October, the crest of steel making activity was reached and about 3,000,000 tons were manufactured. Total production of finished products was about 24,000,000 tons, with bookings about 6,000,000 tons more. Merchant pig iron stocks in the country in some cases comprising iron carried since 1907, were absorbed heavily, notwithstanding the enormous production and at the end of 1912 were roughly estimated at about 500,000 tons, with as much more in the hands of steel-making consumers. Twelve months earlier, total stocks in the country were fully 1,600,000 to 1,700,000 tons.

Political conditions apparently exerted little or no effect upon the year's course of trade and were virtually disregarded. With a change in the national administration looming ahead and with substantial tariff reductions practically assured, the steel industry has, to all appearances, been too busy coping with the problems of production and with meeting an unprecedented demand, to be sentimentally affected by these factors. Interesting speculation remains as to what will be the ultimate result of tariff reductions upon the iron and steel industry of this country when the present period of remarkable worldwide demand, now at its height, shall have subsided, as it must eventually.

The progress of the prosecution by the government of the United States Steel Corporation, has stirred only casual interest, as it is appreciated that an adjudication of this suit is not likely for a year, at least. The hearings of testimony in this action began in New York, on May 6, and are still being continued there and in other cities. The adverse report of the Stanley congressional committee, investigating the Steel Corporation, which was filed Aug. 2, had been largely discounted and was accepted as a document partaking more of the nature of partisan politics than of constructive economics.

The United States Steel Corporation in 1912 produced more pig iron and steel than any other year in its history. Its ingot output will run about 17,000,000 tons or, not quite 3,000,000 tons greater than the largest previous record of 14,179,369 tons, in 1910. In 1911, its ingot production was 12,770,000 tons. The highest monthly ingot output was reached in October, when over 1,600,000 tons were produced. May was another month of large output, showing about 1,500,000 tons of ingots. During the first half of the year, the steel works of the leading interest were employed more fully, relatively, than those of the independents. During the last half of the year, however, the independent companies filled more nearly their quota, which in recent years has been about 47 per cent of the country's total output. The ingot production of the Steel Corporation will average about 55 per cent of the country's total. Of a total pig iron production in the country of 29,000,000 to 30,000,000 tons, the Steel

Average Monthly Prices of Raw and Finished Materials in East During 1912

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Basic pig iron, eastern Pa....	$14.25	$14.25	$14.25	$15.00	$15.00	$15.25	$15.50	$16.25	$16.50	$17.50	$18.00	$18.25
No. 2X foundry, Philadelphia.....	15.00	15.00	15.00	15.25	15.25	15.50	15.75	16.00	16.50	17.50	18.00	18.25
Low phosphorus, Philadelphia.....	19.25	19.00	19.00	19.50	19.75	19.75	20.00	21.00	21.50	22.50	24.00	24.50
Standard gray forge, eastern Pa....	14.00	14.00	14.00	14.50	14.50	14.75	15.25	15.50	16.25	17.00	17.50	17.50
Open-hearth billets, Philadelphia ...	22.40	22.40	22.40	22.40	23.90	23.90	24.40	24.90	27.00	28.50	29.50	29.50
No. 1 heavy steel, eastern Pa.....	12.25	12.00	12.25	13.00	13.75	13.50	13.75	14.25	14.75	15.50	15.25	15.00
No. 1 railroad wrought, eastern Pa..	15.25	14.50	14.50	15.25	16.25	15.75	15.50	16.25	16.50	17.25	17.00	16.50
Heavy machinery cast, eastern Pa...	12.50	12.50	13.00	13.50	13.75	13.75	13.75	14.00	14.00	14.50	15.00	15.25
Tank plates, Philadelphia	1.30c	1.30c	1.25c	1.30c	1.35c	1.40c	1.45c	1.55c	1.60c	1.70c	1.75c	1.75c
Structural shapes, Philadelphia.....	1.30c	1.30c	1.25c	1.30c	1.35c	1.40c	1.45c	1.55c	1.60c	1.70c	1.75c	1.75c
Steel bars, Philadelphia	1.25c	1.25c	1.20c	1.25c	1.35c	1.35c	1.40c	1.45c	1.50c	1.55c	1.55c	1.55c
Common iron bars, Philadelphia.....	1.25c	1.25c	1.20c	1.27c	1.32c	1.30c	1.35c	1.35c	1.45c	1.60c	1.67c	1.72c
Virginia 2X foundry, furnace.....	$12.25	$12.25	$12.25	$13.00	$13.00	$13.25	$13.50	$14.00	$14.50	$15.50	$16.00	$16.00

Corporation furnaces smelted about 14,000,000 tons. Its production of finished products for sale were about 13,000,000 tons, which, with the approximately 3,000,000 tons increase in unfilled orders, made the total bookings in the year about 16,000,000 tons. During the first half, the Steel Corporation's shipments exceeded 6,000,000 tons and this tonnage was much increased in the second half.

East Enjoys Prosperity

The eastern iron and steel industry enjoyed its full share of the year's prosperity. Plant operations generally have been very active and production with some companies has been the heaviest in history. Due to their geographical position for eastern delivery and to their different methods of selling in not freely booking themselves on contracts, the steel companies of eastern Pennsylvania reaped a bountiful harvest from the heavy volume of business directed upon them. Their average price at the mill of their bookings over the year was several dollars per ton higher than that of the larger Pittsburgh and middle western producers. Shortage of labor was keenly felt by the eastern steel mills and blast furnaces in the year and this factor, together with the scarcity of good quality fuel, restrained the carrying out of plans for increased operations, particularly among pig iron makers.

Eastern plate makers produced the largest output in their history in 1912. January, February and March proved poor months in the trade with prices dragging bottom at 1.10c to 1.15c, Pittsburgh, or 1.25c to 1.30c, Philadelphia, and the influence of the expanding demand upon prices was not felt until toward the close of March. From that time, orders increased and tonnage flowed in upon the mills at such a rate that operating capacity quickly reached the straining point and makers at the beginning of 1913 were taxed to take care of the demand. Their order books then were full for six to eight weeks ahead. Eastern plate makers were cautious in booking forward contracts after the permanent revival of the industry became apparent, with the result that consumers far beyond their regular geographical zone, turned to them from the clogged Pittsburgh and Chicago mills. Premium prices of from $2 to $6 a ton above the so-called official market, quickly appeared as the result of these conditions. After several months of irregular values, the eastern market gradually settled in October to a basis of 1.60c, Pittsburgh, for sheared, and 1.65c, Pittsburgh, for universal plates, or 1.75c and 1.80c, Philadelphia, respectively. These prices represented $3 to $4 a ton above the schedules of 1.45c and 1.50c of the larger producers. Eastern plate mills drew heavily in the year from the greater activities of the ship yards, locomotive plants, boiler shops and other principal sources of plate consumption.

Eastern mill prices on structural steel started the year around 1.15c, Pittsburgh, equivalent to 1.30c, Philadelphia, and 1.31c, New York. They then dropped under keen competition until, early in March, some business was taken in the east as low as 1.05c to 1.06c, Pittsburgh basis, or 1.20c to 1.21c, delivered. These extremely low prices did not long prevail. During the last quarter, Pittsburgh makers were quoting 1.45c to 1.50c, Pittsburgh, but could not make deliveries for five or six months ahead. Eastern shape mills were readily taking business at 1.60c, Pittsburgh, for eastern delivery for 10 to 12 weeks' shipment and their schedule more nearly represented the going market. Prompt shapes from mills were selling from 1.85c to 2c, tidewater. The advance in the year on plain material from the extremely low point, therefore, was fully $10 to $11 a ton.

Advances in Prices

For the first time in several years, eastern bar iron makers commanded prices for their product which afforded them good profits and encouraged unusual activities among the mills. As a result, some plants in eastern Pennsylvania and New Jersey which had been idle for several years, resumed and enjoyed good business. The growth in the bar iron demand which caused prices to advance from 1.18c to 1.20c, eastern mill, in the first quarter, to 1.60c to 1.70c, mill, during the last quarter, or $8 to $10 a ton, was greatly stimulated by the inability of consumers to get deliveries from the sold-up steel bar mills. Steel bars became so difficult to obtain that on small prompt lots from 1.85c to 2c, tidewater, was being paid in the last quarter.

Eastern sellers of billets had a quiet market early in the year, but became swamped with business when the shortage of semi-finished steel was first acutely felt generally in the industry under the heavy operations of the third and fourth quarter. Eastern steel was freely shipped into the Pittsburgh district to help out regular buyers and even steel makers who were oversold upon their capacities. Buyers in these cases were willing to pay without hesitancy whatever price was asked by the maker despite the high freight. The Steel Corporation alone took 40,000 tons of open-hearth billets from eastern makers and a round tonnage from southern producers for shipment to its Pencoyd plant and into the Pittsburgh district. Special forging billets sold as high as $40, eastern mill, and regular forging steel was around $34 to $35, mill, in the last quarter. Rolling billets in the year advanced from the low point of about $22, mill, to $29 to $30, mill. Toward the close of the year, eastern makers of billets were so heavily sold that they were practically out of the market except for small lots.

Active Pig Iron Market

When the year 1912 began, eastern Pennsylvania pig iron producers held fair-sized order books accumulated during the buying movement of the closing months of the preceding year. As the prices at which this business was taken were very low, the makers did not load themselves so heavily that they felt obliged to put in additional furnaces to fill their contracts. Merchant iron production in eastern Pennsylvania in January of the year was about 50 per cent of capacity. Current prices then ruled from $14.25 to $14.50, eastern Pennsylvania furnace, for No. 2X, from $13.50 to $13.75, furnace, for basic and from $13.25 to $13.50, furnace, for standard mill forge.

Throughout the first quarter the market was quite stationary and new business moderate. In April a buying movement in basic appeared and prices advanced about 75 cents. Foundry irons also were more active, but their rise was sluggish and reached but 25 cents. This March buying was a part of a general movement which swept across the country and was featured by the appearance of the United States Steel Corporation in the open market for the first time in several years, as a buyer of Bessemer.

After the March movement, the market had a better tone and the advance was steady. In August, there was a sharp buying movement in basic, about 75,000 tons being taken at advancing prices, of which the Lukens Iron & Steel Co. was the heaviest purchaser. First quarter sales then reached the level of $16.25 to $16.50, delivered, or 75 cents to $1 advance. Other grades also moved

(Continued on page 118)

THE IRON TRADE REVIEW

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Building Plants by Wholesale

Newspapers on the Pacific coast, from San Diego and Los Angeles on the south to Tacoma and Seattle on the north, are giving a very large amount of space nowadays to wonderful stories about plants which are to be built on the coast. Of course, these plants are "to rival the United States Steel Corporation", and in that respect they are like a plant which the American consul general at Sydney, N. S. W., recently reported will be built in that country at the cost of $5,000,000. But this so-called "formidable rival to the steel trust" in New South Wales is insignificant, compared with the mighty plants which British capital is to erect on the Pacific coast. The public is informed that the plans contemplate "large steel plants, rolling mills, blast furnaces and other features of the industry to cost $5,000,000 each at the following points: Portland, Puget Sound, Coos Bay, San Francisco, Los Angeles, San Diego, and possibly Vancouver and some suitable port in Mexico". The total cost is to be about $60,000,000. Some of the details are so ridiculous as to mark the stories as unworthy of the slightest attention so far as crediting them in any way is concerned.

An Ohio man, whose operations in San Diego and other parts of the country in past years ended in dismal failure, appears as the chief promoter of the new plans. THE IRON TRADE REVIEW wishes to warn the people of the Pacific coast, and of England, if, as reported, they are interested, to investigate most thoroughly before investing a dollar in any of the pending schemes to build steel and iron plants as above described.

There is a chance for the steady development of iron and steel industries on the Pacific coast, in a legitimate manner, but there have been so many questionable or positively dishonest schemes in the past that it is highly important for those who are interested in the genuine progress of the coast to encourage only such projects as are feasible and supported by men who are neither dreamers nor rascals.

A Wonderful Iron and Steel Year

In every respect, the year just closed has been a record-breaking one in the iron and steel industry. Calendar year tonnage records have been badly broken. About 48,500,000 tons of ore have been moved out of the Lake Superior region, 5,000,000 tons more than in the best previous year, 1910. Pig iron production has aggregated almost 30,000,000 tons, or about 2,500,000 tons more than in the record calendar year, 1910, though in the twelvemonth ended June 30, 1910, practically as much iron was made. Not nearly as much iron was consumed in that period, however, for stocks were accumulated. In the past twelvemonth what stocks there were have been absorbed. In the steel branch of the trade the breaking of records has been still more pronounced, for it has now become normal for the tonnage of steel ingots and castings to exceed the tonnage of pig iron, whereas in 1910 the tonnage of steel ingots and castings fell 1,200,000 tons, or nearly 5 per cent, below the tonnage of pig iron. In sheets, tin plates and wire products, new tonnage records have been made by wide margins, and in the great majority of other finished steel products, records have been broken, though not by such large amounts.

The advance in prices in 1912 broke recent records with respect to the amount of the advance, though the advanced points reached are low relative to high points in the past. The last important advance was in 1909, when southern pig iron scored a total advance, requiring a period of only six months, of about $4 a ton, while northern iron advanced an average of $3.25 a ton. In the past year, the advance in foundry grades in the north and south has been about $4. The disparity in the advances in finished steel prices is more striking, the advance in 1909 being barely in excess of $5 a ton, while this year the advance in base prices has been nearly $7 a ton. The advance in prices for prompt delivery is still greater, while the 1909 movement did not reach a point of very important premiums being paid for prompt shipment.

Despite the fact that prices have advanced more sharply in the past year than in 1909, the levels reached are lower, pig iron by about $1 a ton and steel products by about $2 a ton. For prompt shipment, however, certain finished steel products are

bringing higher prices than at any time in the 1909 movement.

While the year has broken records, it has also broken precedents and has gone contrary to expectations, which were thought to be well founded. Surely, it has shattered the belief entertained in many quarters that a presidential year cannot be a good one in the iron and steel industry, though, as pointed out in THE IRON TRADE REVIEW of July 25, last, the actual historical details have never gone very far towards proving this contention. The movement which has been in progress has proved the baselessness of the fears entertained in the summer and fall of 1911 that should the government bring suit against the United States Steel Corporation under the Sherman law the iron and steel industry could not become prosperous until the matter was settled. It has also been proved that it was an error to claim that the railroads could not become prosperous, and could not become liberal buyers of iron and steel products, unless they were allowed to make general advances in their rates.

The most important thing the year 1912 has shown the iron and steel industry is that its productive capacity is not large in relation to the requirements of the country. This wonderful revival, which has materially advanced prices, has given the mills specifications for a run of three months and has induced buyers to contract for more than six months ahead. There does not appear to have been any phenomenal demand at any point, but in the aggregate a tonnage has been offered producers which they were unable to supply. The requirements of the country have grown apace in the past three years, while the capacity to produce iron and steel has grown very little. Given a continuance of the expansion in demand, the industry will have to increase its capacity very materially.

The Trend of Prices for 18 Years

The three charts which are printed on one sheet as a supplement to this issue show fluctuations in prices of leading iron and steel products for the last 18 years. The figures on which the charts are based are based on the prices published in the market reports of THE IRON TRADE REVIEW. They are computed for the following: Tank plates, Chicago; beams, Pittsburgh; bar iron, Cleveland; Bessemer billets, Pittsburgh; Bessemer pig iron, Pittsburgh; No. 2 foundry, Chicago; gray forge, Cincinnati; No. 2 foundry, Birmingham; steel bars, Pittsburgh.

In the charts for 1911 and 1912, the vertical lines represent weeks, while in the chart covering 16 years, these lines represent months. In the three charts, the horizontal lines show prices in dollars per net ton in the case of finished materials and per gross ton in the case of pig iron and steel billets. The solid and broken lines traversing the diagram indicate changes in the prices at which a very large percentage of the tonnage was placed, but do not show the highest or lowest prices at which limited tonnages may have been placed. For example, in the case of beams, Pittsburgh, $29 is given as the prevailing price for December, because that is the price at which tonnage was taken for future delivery, although many orders for prompt delivery have been taken at considerably higher prices. Our reason for adopting this policy is that we believe that a permanent record of this kind should show the prices at which the great bulk of the business is taken and not the premiums paid on comparatively small tonnages. In the case of pig iron, the minimum quotations for prompt delivery are taken.

The lower chart shows the very short-lived boom in 1895, which followed the period of depression; then the decline in the latter part of 1895, followed by the slow general decline of 1896 and 1897, when in midsummer the lowest prices on record prevailed; the rather steady trend of prices from the middle of 1897 to the fall of 1898; the rapid rise at the close of 1898, followed by the very high quotations of the boom year, 1899; the sharp decline beginning in September, 1899, and continuing until the mid-summer of 1900; a partial recovery at the close of 1900, and the continuance of prices upward during 1901; the rapid advance during the first half of 1902 and sharp decline beginning in the fall of 1902 and continuing during 1903, followed by a long period of prosperity with occasional recessions, ending suddenly in October, 1907.

Owing to the price maintenance policy, which prevailed throughout the year 1908, prices were much more regular than they would have been without it, but with the declaration of the open market in 1909, the chart shows a dip in the lines, and a gradual recovery from the middle of the year. But the high prices attained in other years of prosperity were not reached in 1909. The improvement was temporary and the year closed with prices on a number of products about the same as they were at the beginning of the year. The downward trend started in February, 1910, and continued through that year and up to nearly the close of 1911, when the decline in prices was checked and some advances were made.

The two charts showing prices for 1911 and 1912 present a sharp contrast, because the advance last year was as pronounced as the decline the year before. The only exception to the rule is in the case of southern pig iron, which is quoted at $13.50, Birmingham, for No. 2 at the close of the year, at which price sales are being made, although some of the leading sellers are asking $14, and the low priced iron is rapidly disappearing. For a few days in 1911, southern No. 2 dropped below $10, this not having occurred before since 1904. This year, southern pig iron started upward in March and continued to advance rather rapidly until the $14 price was reached.

The general tendency of prices in recent years not to fluctuate as violently as they did in earlier years has been made more apparent by the past two years. Just as in 1911, a year of depression, the very low points of the past 18 years were not touched, so in the past year of prosperity, 1912, the highest points marked by boom periods were not reached.

Practical Ideas on Extending Foreign Trade

Vice-President Johnston of the Bethlehem Steel Co. Tells How Americans Could Increase Their Exports — Why the Germans Succeed When Others Fail

By C J Stark

WHEREVER business men are meeting these days in chance groups or in formal convention to consider the common problems of their lines of work, two subjects invariably push their way to the front in their discussions. Very obviously, one is the tariff. The tariff has become so interwoven into the commercial fabric of the nation that to many minds it represents an ingenious and delicate mechanism upon which a placard "Don't Touch" should be displayed in flaming letters of warning to the general public. The strong promise that this injunction is about to be brushed aside and violated, and the aforesaid mechanism touched up pretty lively brings just now the question of high duty, low duty or no duty, into bold relief, wherever men of business affairs are gathered.

There is a second subject, however, which is beginning to rival the tariff, in profound importance, among that class of business men whose recognition and treatment of commercial problems rise to the scale of genuine statesmanship. This subject relates to the necessity for the extension of the foreign trade of the United States and for the making of this country a world power in commerce. Many men observe a relation somewhat akin to cause and effect between imminent tariff reduction and increased advocacy of foreign trade extension. However this may be, it does not require a deep observer to note that a new spirit for commercial conquest beyond our borders is ripening on all sides in this country. The drawing near of the completion of the Panama canal has undoubtedly given great impetus to such a line of business thought.

Notable successes have already been won by American manufacturers in exploring and acquiring foreign fields of trade, but, generally speaking, the great body of wholesale producers of this country is inexperienced or without definite ideas of the problems to be met in such enterprises. One company which has recently been gaining conspicuous headway in the export field is the Bethlehem Steel Co. For this development, Archibald Johnston, vice president of the company, has been the moving spirit. Recently he crowned nine months' stay in the republic of Chili with notable success.

Many manufacturers of the United States regard, and with reason, the republics of South America as the most logical territory for the opening of fruitful avenues of demand for our home products. Accordingly, I asked Mr. Johnston to outline the conditions and problems as he found them in foreign trading, and how they must be overcome by the business men of this country. His remarks encompassed broadly the conditions that surround the marketing of American manufactures of all types in South America and they afford especial interest to the iron and steel maker.

Mr. Johnston's Career

Archibald Johnston has been connected with the Bethlehem works ever since he graduated from Lehigh University as mechanical engineer in 1889. *He entered the physical testing department of the Bethlehem Iron Works in that year and later was placed in charge of the erection and operation of the gun forging plant, the first to be established in this country. In* 1890, *he took charge of the erection, and later conducted the operations of the armor plate department, which was also the first to be built in this country. This position he held for a number of years. He was then made assistant general superintendent and later vice president of the Bethlehem Steel Corporation. He is a member of the Iron and Steel Institute, of the American Iron and Steel Institute, and of various engineering organizations and clubs. Mr. Johnston is a native of Phoenixville, Pa., having been born there May* 30, 1865.

* * * *

Mr. Johnston is a fine example of the American trade crusader. Pleasant and gracious in manner and speech, of commanding stature and dignified appearance, he presents conspicuously the essential asset of a winning personality. Backing this equipment of natural finish, is the practical business acumen of a man of large affairs founded upon many years of experience as a leading steel producer. After all, nowhere must business-getting reach so closely a high art of diplomacy and quiet enterprise as in handling the complex details of a transaction with a foreign-speaking and foreign-trained customer, particularly of the courtly and obsequious Latin types.

During a busy day at the New York offices of the Bethlehem Steel Co., at 111 Broadway, Mr. Johnston talked most entertainingly of foreign trade problems.

"When I went to Chili last April," he said, "I had the idea that it was a country where the people came dressed in feathers and paint. As a matter of fact, the Chileans we met were most hospitable and highly educated. There is no higher civilization anywhere than exists right in Chili today. It is not with me to speak disparagingly of my own country, but the educated Chileans are better educated than we are. This does not apply to mechanical knowledge. The Chileans are better linguists than we are because they teach in the public schools Spanish, French and English and many speak German and Italian, as well. I was extremely surprised to find such a set of conditions extant in Chili, as most Americans are, due to the fact that our people have had very limited relations with Chili or other foreign countries. Our country is so large that it has demanded nearly all we produce of whatever nature and only in recent years have we been reaching out for foreign trade."

"Maybe the expectation of permanent tariff reduction and the probability of less controlled home markets are stirring American manufacturers to reach out more actively for foreign trade," I ventured.

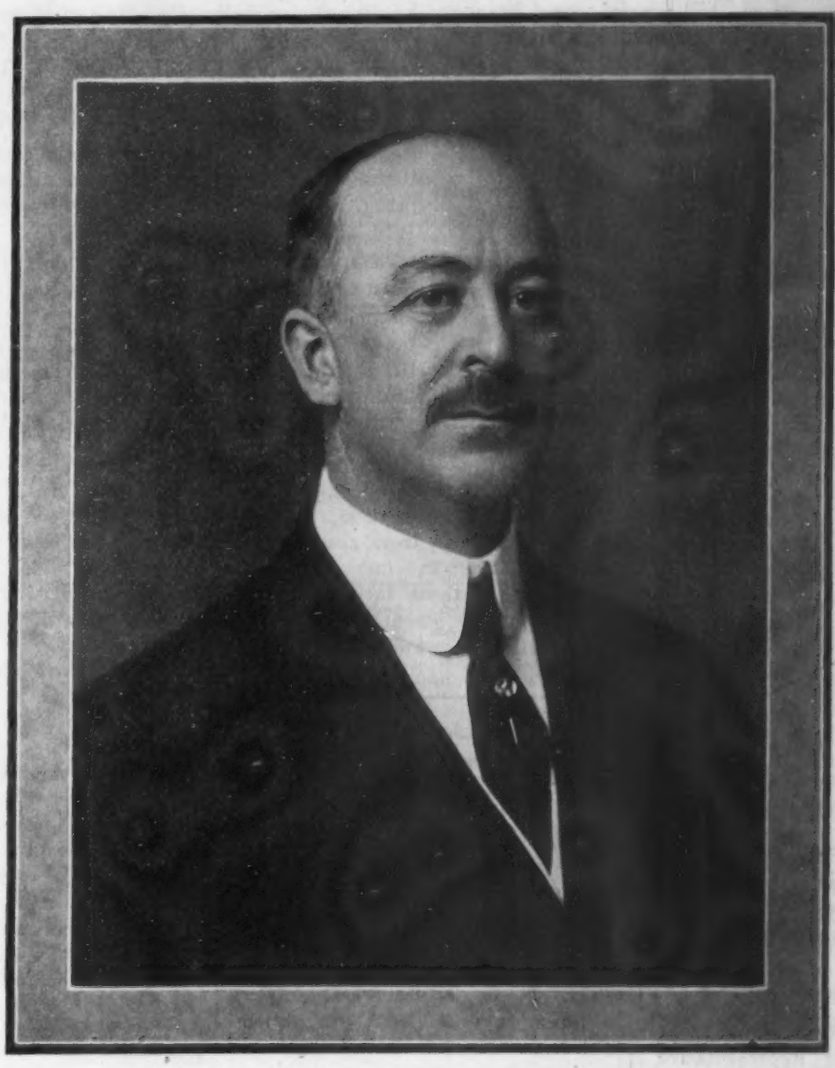
"The tariff is too much of a personal matter with my company for me to discuss that feature of the case." he answered. "This, however, is not the real reason why the Amer-

ican producer shows a greater desire to extend his market beyond the boundaries of this country. The real reason is our greatly increased manufacturing capacity and the growing inability of the country to absorb all that is being produced within it."

* * * *

"Why is it, Mr. Johnston, that the American manufacturers seem to be laboring under a disadvantage in competing with their foreign rivals for export trade?" I asked.

"I find that which hampers us most in these efforts, is that we know little about the export business and, therefore, are unable to play even with our foreign competitors," was the reply. "Export business is in a class by itself. As exporters, we have worked against great odds, due to our ignorance of the commercial conditions existing in various countries. Furthermore, our present position of inequality is due to our ignorance of the language of the countries in which we desire to exploit our goods. As evidencing the truth of this, I found the Chilean able to transact business with us because he was well acquainted with our language and customs. In Valparaiso, practically every one of the commanders of the Chilean navy speaks English and speaks it fluently. This is largely due to the fact that most of the requirements of the Chilean navy have been furnished by English firms. Of recent years, however, the Germans have made great strides."



"Why is it the Germans are such successful exporters?" was my next natural query.

Mr. Johnston spoke with the grasp of one who has intimately studied the subject: "The reason is first that the German, above everybody, speaks the language of the country with which he seeks to do business. In addition to this important fact, the Germans colonize. They have colonies of their own people living in Chili, and to further aid them they have a chain of very efficient banks in all of the larger cities. This condition applies generally in the larger cities of the Argentine Republic, Uruguay, Brazil and other countries. These banks are very well and efficiently managed by Germans who cater to the desires of the people of the country, living among them and becoming one of them, so to speak. In contra-distinction to this condition, there are no American banks, no American newspapers in any of the larger cities of South America.

"The newspaper problem in South America is of great importance. It is too much to expect that the countries with which we are competing will exploit our products against their own. The English papers lose no opportunity to show off the Americans at a disadvantage before the native population. It is not so much what the articles say as what they insinuate or imply, leaving the South American to draw erroneous conclusions of our people and of the treatment he would receive at our hands.

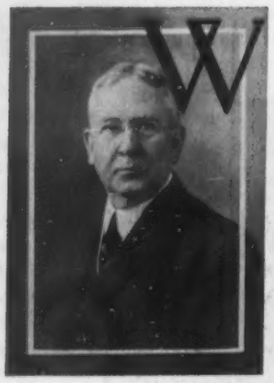
"When an American ships his material to South America, his invoice and bill of lading goes to the German or English banks for exchange. The finances of the American manufacturer, therefore, are handled by the very firms with which he has to compete. There is no country, as far as my observation—based on many years' travel—goes, that is so well equipped commercially to handle foreign business, as Germany. This is due to the conditions above outlined and is the result of the enterprise of the Germans and the very superior set of commercial conditions under which they work. These banks receive copies of the bills of lading, which describe the goods and by reason of handling the finances, know the price at which you sell the customer. This information gives the Germans an inside line on any business transaction by Americans. I lay stress particularly upon Germany as our principal rival in the export trade, due to the fact that the information obtained through these channels of information is circulated more particularly by the German government than by any other. While the English have access to the same information, it is not as successfully transmitted to their manufacturers as it is by the Germans and to this condition I at-

(*Continued on page* 125)

Steady Downward Revision of Metal Schedule

Shown by Comparing Tariff Laws of Past Years—What the Underwood Bill Proposed—How Various Measures Have Cut Iron and Steel

By Arthur J Dodge



WHEN it is reflected that, by the terms of the iron and steel tariff revision bill proposed by the Democratic majority in the house, and which was agreed to by the senate and ultimately vetoed by President Taft, approximately $25,000,000 worth of additional iron and steel products would be admitted to the markets of the United States, according to the estimates made by the framers of the bill themselves, it is not surprising that there should be considerable interest displayed by iron and steel manufacturers in the prospect of such a measure finally becoming a law under the new administration. It is a matter of vast importance to those interested in the iron and steel industry, and all allied industries that would be directly or indirectly affected by this measure, to note what effect this proposed legislation would have upon different branches of these industries, and why it is that iron and steel appears to have been singled out by the tariff makers for more sweeping reductions in duties than has been thought of in connection with any other features of the various tariff schedules. It is also of considerable interest to reflect upon the changes that have been made in the tariff duties on iron and steel products during recent years as indicating, as they do, a settled purpose on the part of tariff makers under all administrations to cut more deeply into the duties on iron and steel than in any other rates of duty covered by the various schedules of the tariff.

However these various changes that have been made in the iron and steel rates of duty during recent years are considered, it comes to be a matter of some surprise that so sweeping a reduction was contemplated by the dominant party in the house of representatives during the present congress, and the natural source of inquiry among all who are concerned about these duties is to know whether the propositions as advanced with respect to the various items in the iron and steel schedules are to be adopted by the Democratic majority in both houses in the next congress and ultimately to be signed in the form of a bill by the incoming president.

Underwood's Plan

Intimations have been given that it is the purpose of Representative Underwood, of Alabama, chairman of the ways and means committee of the house, and his colleagues to attempt during the present winter to formulate tariff bills which will be presented from the committee promptly in the special session in April, of which President-elect Wilson has already given notice. The suggestion has been made in many quarters that the Democratic majority will not be able to secure assent to tariff bills asking such sweeping reductions in rates of duty as were proposed at a time when the party was not in position to carry its propositions into affirmative law. Of course, this remains to be seen. It is a matter of speculative interest just how far the framers of these tariff bills will be willing to go when they are confronted with the power to make effective what results from their efforts.

One of the prime reasons given by the representatives of the iron and steel industries of the country why the bill which was passed by congress in the last session promptly was vetoed by President Taft was that, even aside from the unnecessarily heavy reduction in duties in many lines covered by the schedule, there was reckless action by the framers of the bill in placing on the free list many articles of highly finished character, a policy that is entirely out of consonance with the usual policy displayed in making tariff bills. Ordinarily all tariff bills that have been prepared in times past have proceeded upon the assumption that the more highly finished articles, upon which a greater amount of labor has been expended, should carry proportionately higher rates of duty than raw materials or articles of less cost of production. It was on this account that such vigorous opposition was made to the features of the bill placing machine tools and many other finished iron and steel products on the free list.

In any consideration that is to be given to the revision of tariff schedules at this time, it would be well for everybody who has anything to do with the subject, or who would be in any way affected thereby, to reflect upon the changes that have been made in recent years, and also upon the possibilities of disaster resulting from too sweeping reductions, if made at a time when competition is keen throughout the industry in this country and in foreign countries. It has been alleged that one striking feature of the Democratic tar-

Arthur Dodge's Career

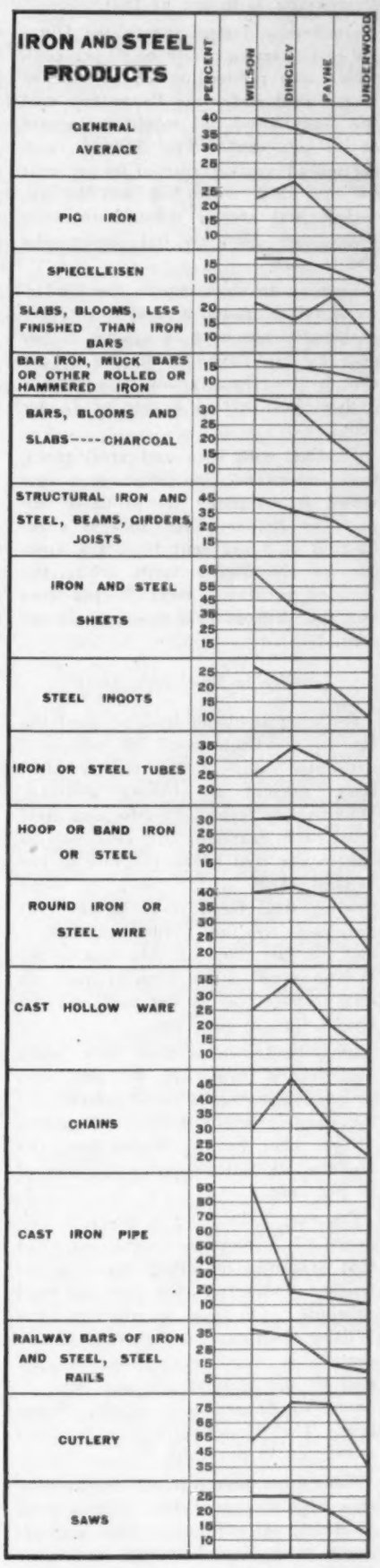
Arthur J. Dodge has been a Washington correspondent for 25 years and is one of the ablest members of the press gallery in the halls of Congress. He represents daily newspapers and trade publications. He is also a lawyer and a member of the District of Columbia bar. He is a writer upon economic and financial questions, having written monographic histories of gold and silver and paper money of the United States as well as many articles on various phases of the tariff question. He is considered one of the best authorities in Washington on tariff matters. He is president of the Press Club at the national capital.

iff policy, indicated especially in the bill which the majority party in the house framed during the last session covering this subject, was the manifest disposition to make heavy reductions in duties upon articles about which it was shown that a considerable part of the aggregate production in this country was controlled by the United States Steel Corporation, or where it was disclosed that any number of the larger and better equipped steel works in the country were able to produce these articles at large profits. In other words, very little consideration was given to the question as to how the smaller concerns engaged in these enterprises were to exist if account were taken in tariff making of only the larger and better equipped plants.

The McKinley Tariff

During the period covered by the McKinley tariff, from 1890 to 1894, when the Democratic Wilson law went into effect, the average rates of duty in the iron and steel schedule of all tariff laws ranged comparatively low, and lower as a matter of fact than they were fixed by the Wilson tariff law of 1894, which, it was said, operated disadvantageously to the industry in this country as a result of increased foreign competition. The average rates of duty in a tariff law afford very little explanation of results which may actually flow from such duties and it is only by noting specific items that one gets an idea of the possibilities which may flow to particular industries. During the life of the tariff act of 1883, or down to 1890, when the McKinley law became effective, the average rates of duty ranged at about 38 per cent on all the items covered by the iron and steel schedule. These average rates of duty, it must be recalled, are based, not upon current prices in the American market, but are the average ad valorem rates of duty based on prices of foreign iron and steel products as they are subjected to duty on entry into the markets of the United States. The McKinley tariff made so many increases in various items of the tariff schedule that the average ad valorem rate was materially increased and rose to an average for four years of about 47 per cent. Then came the tariff law of 1894, made by the Democrats under the supervision of Wilson in the house and Gorman in the senate. The average ad valorem rate of that law, through its life, was about 40 per cent, or 7 per cent lower than the McKinley tariff.

It is interesting now to observe what was done by the Dingley tariff, which remained in existence from 1897 until 1909, when it was superseded by the Payne law. The average rate of duty on the entire schedule for that period was about 37 per cent, or approximately what it was back in the days of the 1883 tariff. Under the Payne law, so many reductions were made in the various duties covered throughout the iron and steel schedule that during 1910, after the law had been in operation but a year, the average ad valorem rate of duty under the law of importations was about 33 per cent. In the following year, it fell to 32 per cent. The general estimate made by the framers of the last proposition for reducing iron and steel duties, as the estimate was made by Mr. Underwood and his colleagues, calls for a rate of duty of but 22 per cent, or a flat cut of 10 per cent lower than the general average rate at any time during the last 20 years. Naturally the question arises whether conditions in the trade, following so sweeping a reduction as an average of say 15 per cent, so soon after the revision by the Payne tariff law four years ago.



TARIFF CHANGES IN GRAPHIC FORM

Metal Trades Most Important

It is one of the notable things in connection with the iron and steel industry, recognized by makers of tariff laws in all congresses of recent years, that the metal trades constitute the most important factor in the trades and industries of the country. The fact was brought out in a discussion of the possible, but not known effects of Mr. Underwood's tariff bill, which was vetoed by President Taft, that nearly 60 industries in the United States not directly mentioned in the items of the tariff law itself would be directly or indirectly affected by the reduction in the rates of duty on iron and steel.

Adverting now to the fact that the Underwood bill of the last session is to be the basis of a tariff revision bill covering the iron and steel trades in Mr. Wilson's administration and is to be brought promptly to the front during a special session in the early spring, it comes to be a matter of concern to everybody connected with these trades to notice wherein the most sweeping reductions in duties made in the various paragraphs of the schedule compare with the general average reductions sought to be made by Mr. Underwood and his colleagues when they framed the bill. In other words, to compare reductions of about 15 to 20 per cent in the general ad valorem rate with some of the reductions made in the more important items of the schedule. To make these points more effective, it is desirable, in specifying these important

items in the bill, to note the changes that have been made by the Dingley and Payne laws compared with what Mr. Underwood and his colleagues proposed, and also the rate of duty which was carried in the last Democratic tariff act of 1894.

Rates on Pig Iron

Starting with the item of pig iron, which carried a duty of 28 per cent under the Dingley tariff and was reduced to about 16 per cent under the Payne tariff, the Underwood bill, which was vetoed, would carry a rate of only 8 per cent. Compared with the Democratic tariff act of 1894, that is a reduction of more than 16 per cent.

The rate proposed by the Underwood bill on spiegeleisen is fixed at 8 per cent as against nearly 17 per cent in the Wilson bill, and this in the face of the fact that the Dingley rate of about 17 per cent was reduced to 13 per cent by the Payne tariff.

In the matter of slabs, blooms, less finished than iron bars, the Dingley tariff carried a rate of about 16 per cent; the average ad valorem rate under the Payne tariff was higher on this item, or an average of about 24 per cent. The Underwood bill would reduce this duty to 10 per cent, which is less than half of the rate carried by the Wilson tariff law. A similar reduction was made by the Underwood bill on bar iron, muck bars and other iron, either rolled or hammered. The Wilson bill carried a rate of 17 per cent on these items, compared with about 13 per cent under the Payne law and 15 per cent under the Dingley law.

On bars, blooms and slabs, in the manufacture of which charcoal is used, a striking illustration of sweeping reductions was made by the Underwood bill. This rate was made approximately 10 per cent by the Underwood bill as againt 34 per cent under the Wilson and 32 per cent under the Dingley law, which had been reduced to 20 per cent under the Payne tariff.

A corresponding reduction was made on imports of structural iron and steel, beams, girders, joists, etc., which carried a rate of 36 per cent under the Dingley law, reduced to 30 per cent by the Payne tariff, and the Underwood bill proposed a duty of 15 per cent. The Wilson tariff carried a rate of 45 per cent on these products.

It will thus be seen that on most of these items, in fact practically throughout the various items of the bill, the reductions range from 10 to 50 per cent compared not only with the existing law but also with the Democratic tariff act of 1894.

On iron and steel sheets, the Dingley tariff carried a rate of 40 per cent, which was reduced to an average of 30 per cent under the Payne law, and the Underwood bill would fix a rate of 15 per cent. The Wilson tariff carried an average rate of 64 per cent on this item which, as will be observed, was greatly reduced not only under the Dingley but under the Payne tariff.

Turning to steel ingots, the Underwood bill proposed a rate of duty averaging 10 per cent as against 21 per cent by the Payne tariff and 20 per cent by the Dingley law, whereas the Wilson law carried a rate of 27 per cent.

Dealing with iron and steel tubes, the Underwood bill proposes a rate which is estimated on probable imports of 20 per cent. This is a reduction of 9 per cent from the average of the Payne tariff, while the Dingley tariff rate was 35 per cent and the Wilson tariff rate was 25 per cent.

Decline in Band Iron Tariff

On hoop and band iron or steel the rate of the Underwood bill compared with the rates of the former tariff laws, present a striking contrast. Whereas, in respect to iron and steel tubes, for example, the reduction is only 5 per cent below the rate of the Wilson tariff, as to hoop or band iron or steel the rate of 15 per cent proposed by the Underwod bill is half the rate fixed on this item in the Wilson tariff. The Dingley rate on this product was 31 per cent and the Payne rate 25 per cent.

On round iron or steel wire, while the Wilson rate was 40 per cent, which was increased to 42 per cent by the Dingley law and then reduced to 38 per cent by the Payne law, the Underwood bill proposes a rate of 20 per cent.

On cast hollow ware, there is evidence of a more sweeping cut than that proposed on other items in the finished products of the iron and steel schedule. On this commodity, the Wilson tariff carried a rate of 25 per cent; this was increased to 35 per cent by the Dingley law and then reduced to 20 per cent by the Payne law. The Underwood bill proposes a rate of 10 per cent.

Cast iron pipe carried an average rate of duty under the Wilson tariff of nearly 90 per cent. This was reduced to a general average under the Dingley tariff of about 19 per cent. The average rate of duty on this product by the Payne tariff was about 16 per cent and the Underwood bill proposes a 10 per cent rate thereon.

On iron and steel chains, which carried a rate of 30 per cent under the Wilson law, 47 per cent under the Dingley law and 31 per cent under the present Payne law, the Underwood bill proposes a rate of 20 per cent.

Rail Duties Compared

An average rate of 10 per cent is proposed by the Underwood bill on railway bars of iron and steel, steel rails, etc., as against an average of 15 per cent under the Payne tariff, which had been reduced from 34 per cent by the Dingley law. The reduction on railway fish plates as proposed is approximately the same as that on rails.

On cutlery, highly finished and expensive, in many instances, the rate proposed by the Underwood bill is 35 per cent as against 77 per cent by the Payne law and 79 per cent by the Dingley tariff. The rate carried in the Wilson tariff in 1894 was 53 per cent.

An illustration of what was proposed to be done with respect to saws of various kinds, the rates ranged in the Underwood bill at about 12 per cent as against from 20 to 25 per cent under the Payne law and 25 to 30 per cent under the Dingley tariff. The rate carried by the Wilson tariff ranged at about 25 per cent.

The foregoing reference to the various changes, of course, does not begin to cover the hundreds of changes made in the iron and steel schedule by the various tariff acts. They serve, however, to show the general trend of these changes, not only as they were proposed by the Underwood bill, but as they were made in the tariffs of recent years. In addition to the sweeping reductions intended to be made by the Underwood bill, various items, from iron ore up through to finished barbed wire, cut nails, wire nails, cash registers, linotype machines, tools, sewing machines and typewriters, were all to be carried into the free list, regardless of the labor that had been expended in the production of them.

It is an interesting feature of the Underwood tariff bill, as it was prepared, that while it proposed to swell the total annual importations of iron and steel products from approximately $53,000,000, the present imports, to $78,000,000, this bill, according to estimates made by its framers, would actually decrease the total annual revenues by approximately a million dollars.

GREAT EXPECTATIONS

For the New Year—Railroads Buying Rails Freely.

New York, Dec. 31.—Although in comparison with some big business done in pig iron during the past year, the market today is rather quiet, this does not signify entire absence of business, as orders are coming in all the time and making unexpectedly good aggregate for the closing days of the year.

Since Dec. 25, orders have been booked by local sellers that will total close to 50,000 tons of various grades, and the business was closed at full prices. Shading reported in the south has not reached northern sellers and there does not appear to be any anxiety that price reduction is probable for a long time ahead. The demand for finished and semi-finished materials continues heavy and it is the opinion of those in a position of great advantage for gaging the future that next year will eclipse any established records of business activity in this country. Railroads placed orders for about 100,000 tons of rails recently, including 4,000 for the Monon, about 30,000 for the New York Central, 10,000 for the Vandalia, and 10,000 for the Minneapolis & St. Louis.

STRUCTURAL CONTRACTS

Placed at Chicago Make Large Total —New Ore Dock.

Chicago, Dec. 31.—The year closes with an unusually good list of structural contracts, totaling 25,475 tons. This material leads the market in activity, specifications having been received calling for delivery late in the second half and new business having been taken for delivery in January, 1914.

The bulk of the tonnage in this list is embodied in the contract for 22,000 tons taken by the American Bridge Co. for the construction of the Duluth, Missabe & Northern Railway Co.'s new ore dock at Duluth. This dock will be the largest in the world and it is understood that construction will be pushed forward as rapidly as possible.

Pig Iron Quiet But Strong

Philadelphia, Dec. 31.—The pig iron market is quiet but strong and indications point to considerable activity in No. 2 foundry early in January. Some of the 25,000 tons of pipe iron recently sold to Delaware river companies was resale iron and was obtained at a price slightly less than the usual quotation. A Delaware river pipe maker has inquired for 7,500 tons of low grade pig iron for delivery in the second quarter.

HEAVY SPECIFYING

Continues in the East—Reported Sale of Billets.

Philadelphia, Dec. 31.—Steel bar specifications continue heavy. Plate tonnage on the books is increasing and deliveries are more extended. A large volume of plate inquiry has been received from Canadian car builders and structural fabricators the past week. Demand for structural shapes is unusually heavy for this time of the year. It is reported that the Phoenix Bridge Co. took 800 tons from the New York Central for bridge work. Plans are out for a garage involving 250 tons and also for an University of Pennsylvania building, calling for several hundred tons. The Pennsylvania Steel Co. has taken 1,500 tons of rails for trolley roads in New England.

It is reported that the Carnegie Steel Co. has closed with Southern Iron & Steel Co. for 15,000 to 20,000 tons of re-rolling billets for Pencoyd works for delivery during the first half. Large makers of billets are sold up for first quarter, and a few contracts have been made for second quarter. The demand for sheets is very strong and deliveries are falling behind. Sheet makers have not raised prices, but are offered premiums of $3 to $5 per ton on new business, which they are unable to take care of.

INTO NEXT YEAR

Deliveries of Cars Will Extend—New Orders Placed.

Chicago, Dec. 31.—The year closes with no cessation in car buying. Builders are covered by contracts, but will be unable to obtain prompt deliveries. The total booked is sufficient to run well into 1914. The Atchison, Topeka & Santa Fe has ordered 900 refrigerator cars, 900 furniture and 900 gondola cars from the American Car & Foundry Co., and 35 steel coaches, 25 all-steel chair cars, 20 all-steel baggage and mail cars, 30 all-steel baggage and express and two parlor cars from the Pullman Co. The Denver, Northwestern & Pacific has ordered 300 gondolas from the Pressed Steel Car Co., and 125 stock cars from the American Car & Foundry Co.

KEEN INTEREST

In Prices of Southern Iron—Northern Producers Strong.

Chicago, Dec. 31.—Owing to the large amount of pig iron sold in this territory, there is naturally considerable interest in the prices of the southern product for future delivery. While in some quarters there is a disposition to believe that there is a tendency toward weakness, this is probably due more to the expression of the hopes of the buyers than to anything else. Much depends upon whether a good buying movement starts in January. If it does, prices will be maintained at the present level. The southern market today is stronger than it has been recently.

Northern producers report that they are in a strong position, one Chicago furnace interest having recently taken more business than at any time since election.

The only sale of consequence reported was 1,000 tons of northern for delivery in January and February.

Selling at Full Prices

New York, Dec. 31.—A local seller has taken a number of orders for small tonnages of No. 2 foundry, aggregating 2,000 tons, at full prices. Buyers seem entirely willing to pay market prices when they can get the kind of iron that they want. Inquiries for about 12,000 tons are pending and dealers are looking forward to good business through the first quarter of the new year.

Railroads Buying Shapes and Rails

Chicago, Dec. 31.—Railroad purchases of shapes and rails continue heavy. The Illinois Central has ordered 1,600 tons of channels from the Cambria Steel Co. The St. Louis & San Francisco ordered 3,600 tons of shapes from the McClintic-Marshall Construction Co., and the Virginia Bridge Co., and 900 tons of bridge steel from the American Bridge Co.

P. M. Wetmore, general superintendent of the Carbon Steel Co., Pittsburgh, has been appointed manager of sales. He will be succeeded as general superintendent by G. E. Middleton, formerly assistant superintendent of the Shoenberger plant of the American Steel & Wire Co. D. R. Wilson, formerly in the eastern sales office of the company, has been elected treasurer.

Crude Oil Situation is Acute in Milwaukee

Rapid Advance in Prices Makes Action Imperative—Current for Electric Furnaces Offered at Low Cost by Railway Company

By J L Meyer

THE crude oil situation in the Milwaukee district has now reached a critical stage, following the general advance in prices to $5.70 to $6 per 100 gallons, effective Jan. 1. The effect of the advance may best be seen from the fact that approximately 12,500,000 gallons are consumed in the Milwaukee district alone.

The advance was, of course, not unexpected, as only a short time ago the Standard Oil Co. of Indiana announced that after Jan. 1, no more crude oil would be supplied in its territory because the entire supply of raw oil was needed for the production of the higher distillates, such as gasoline, naphtha, benzine, kerosene, etc. During the past year, the price has been advancing steadily from $2.50 per 100 gallons to $4.50, to $5.10, which is now increased to $5.70 to $6, and a supply considerably diminished is to be faced.

Outside of the fact that Milwaukee crude oil users would have great difficulty in getting sufficient stock to operate, the fact that the advanced prices on crude oil makes its use almost prohibitive caused great concern among foundries. The smaller foundry people will not be able to stand the large expense of converting their crude oil furnaces to suit the use of producer gas, not alone because of the heavy initial expense, but of the higher price they would be required to charge for their products and the consequent protestations from consumers against the use of their products under the advance made necessary by such conditions.

Prepared for Change

Nearly all of the larger manufacturers began making preparations for the change some time ago, while others started when the situation became acute a month or two ago with the announcement of the Standard Oil Co. of Indiana. The large companies which have contracts for crude supplies well into the first half of 1913 have not been in a great hurry, but even their plans are well advanced and they will be ready when the time comes.

The largest user of crude in the Milwaukee district is the Falk Co., which takes approximately 2,000,000 gallons annually. The Falk people, who are now engaged in the construction of a producer gas plant, figure that at the new quotations they can save $55,000 per year by using producer gas. The dividing line in Milwaukee between oil and coal for the intense heats required in this class of steel production is said to be about 3 cents a gallon for oil. When the crude product goes above that figure, producer gas becomes the cheaper fuel.

Gen. Falk's Opinion

Gen. Otto H. Falk, vice president of the Falk Co., receiver of the Allis-Chalmers Co., and president of the Merchants and Manufacturers' Association, of Milwaukee, in an interview said:

"The big jump in fuel oil prices not only will seriously affect the smaller concerns, but puts all Milwaukee producers at a great disadvantage compared with those of other localities which have big oil refineries near them or which are in the natural gas belt. The Falk Co.'s oil contract expires Jan. 1, but we are well along with the work of building our new producer plant, which will be ready for operation some time in February. We were lucky enough to get in ahead of the rush with our orders for the outfit."

Richard P. Tell, vice president of the National Brake & Electric Co., which uses 1,250,000 gallons of crude annually, said: "Our contract expires Jan. 1, but we have been lucky enough to turn around and get a contract with another oil company. What we will do after that contract expires, is still a question."

The Bucyrus Co., of South Milwaukee, is now engaged in the construction of a producer plant, which will be ready May 1, when its present crude supply contract expires.

The Allis-Chalmers Co. has taken similar measures for the new hydraulic forge shop at West Allis.

The Prime Steel Co., using 600,000 gallons per year at its Mitchell street plant and 300,000 gallons at the Chicago avenue works, is figuring on a producer plant, to be ready when its present contracts expire about the end of the first quarter of 1913.

The Waukesha Steel Co.'s contract with the Standard expires Jan. 1, but a new contract has been placed elsewhere at an advanced figure, running to July 1. The company accepted the advance because it was unable to make any changes during the present heavy rush of business and did not care to make any sacrifices at this time by changing its furnaces. Work on a producer plant will be taken up at once, however.

The A. O. Smith Co. has a contract until April 1, and is planning to use electric furnaces for heat treatment of steel after the crude supply is cut off. It has already installed a small producer plant for part of its processes. The company uses 900,000 gallons annually.

The Crucible Steel Co., using 175,000 gallons per year, is putting in electric furnaces, to be ready Feb. 15.

The Maynard Steel Castings Co. has a contract running until April 1.

The George H. Smith Steel Casting Co. reports that it received a three-line letter notifying it that the oil company would not be able to furnish fuel oil henceforth, but later received an offer at less than $5 per 100 gallons, indicating a change of purpose.

The Gerlinger Steel Casting Co. is part user of another oil product known as "distillates."

Abandoned Crude Oil

Milwaukee malleable manufacturers abandoned the use of crude oil for fuel some time ago, because of the steady advance in price, and are not seriously affected by the advance in price and threatened shutting off the supply. Considerable crude is used, however, the Wisconsin Bridge & Iron Works consuming 150,000 gallons annually. Other structural makers are not using any appreciable amount. The Pawling & Harnischfeger Co.'s crane works changed over from oil two years ago. The Milwaukee Gas Light Co.'s contract runs to Jan. 1, 1914. Since it made a contract with the Solvay people, the

company has used little fuel oil, the present consumption being not more than 100,000 gallons annually. Fuel oil is used only in the water gas process.

The consumption of the largest users of crude in the Milwaukee district may be summed up as follows, in gallons:

The Falk Co.	2,000,000
Allis-Chalmers Co.	1,250,000
National Brake & Electric Co.	1,250,000
Prime Steel Co.	900,000
A. O. Smith Co.	900,000
Sivyer Steel Casting Co.	750,000
Geo. H. Smith Steel Casting Co.	600,000
Bucyrus Co.	600,000
Waukesha Steel Co.	500,000
Wehr Steel Co.	355,000
Nortmann & Duffke Foundry Co.	175,000
Obenberger Drop Forge Co.	185,000
International Harvester Co.	185,000
Bay View Steel Casting Co.	180,000
Wisconsin Bridge & Iron Co.	150,000
Maynard Steel Castings Co.	100,000
Standard Crucible Steel Casting Co.	75,000
Gerlinger Steel Casting Co.	60,000

A feature of the situation in the Milwaukee - Waukesha district has been the prompt offer of the Milwaukee Electric Railway & Light Co. to supply current for electric furnaces, to replace oil-burning furnaces, at a very low price per kilowatt-hour. This current will be brought nearly 100 miles from the company's auxiliary water-power plant at Kilbourn on the Wisconsin river. The transmission line now passes directly through Waukesha and West Allis and connects with trunk lines to North Milwaukee, Bay View, Cudahy and South Milwaukee, at which the largest metal-working plants are located.

As there is a large hollow in the Electric Co.'s commercial day load, between the morning and evening peak loads, current for electric furnaces will tend to fill this in, and such equalization of the demand enables power to be profitably furnished at a very low price if taken in large quantities for the purpose mentioned. Future developments are, therefore, being watched with great interest. For the present the use of electric furnaces will probably be confined to small sizes; but if apparatus of larger capacity is found suitable and economical for the heavier work, it will find a promising field of application wherever cheap hydro-electric power is available.

Otis Steel Co. Official Killed

H. B. Hare, assistant secretary and assistant treasurer of the Otis Steel Co., Cleveland, was killed Dec. 28 in an automobile accident in that city. Mr. Hare was driving home in his automobile when it broke through the railing around an open ditch. He was thrown into the ditch and almost instantly killed. He was 42 years of age, having been born in Summerfield, O., on June 12, 1870. His association with the Otis Steel Co. began 12 years ago when he entered the sales department. He was later promoted to be assistant secretary and was made assistant treasurer only recently.

GREAT VOLUME

Of Orders and Specifications on Books of Chicago District Mills.

Chicago, Dec. 31.—The Steel Corporation mills and also those of independents of this territory have a larger volume of business on their books than ever before and operation at capacity seems certain for at least six months unless a wholly unexpected crisis should result in the cancellation of orders. Up to the present time, neither fear of financial troubles nor dread of radical tariff legislation has had any effect. Even the lull which would be expected after the accumulation of such a vast volume of business is not in evidence. It is true that comparatively little business is being booked, but that is because the mills will not take it, for large tonnages are being offered. While there is always some tonnage that may be called speculative, it is believed that there is less of it at this time than at any previous boom period. The Lackawanna Steel Co. is among the companies which are pursuing a very conservative policy in an effort to eliminate speculation. December will probably rank as the fourth month of the year in the volume of business taken by the Steel Corporation.

MANY INQUIRIES

For Cast Iron Pipe and Prices Are Firmly Adhered To.

Chicago, Dec. 31.—The outlook in the cast iron pipe market is very favorable and the placing of new orders early in the year is expected. Minneapolis has received bids for 3,000 tons of cast iron water pipe and St. Paul for 1,000 tons. At Grand Rapids, a contract for a small tonnage has been closed. Many other inquiries from municipalities are expected soon.

The cast iron pipe market is very sensitive to influence of the pig iron market, and, if pig should decline, it would be difficult to maintain quotations on pipe, but at present there is little ground for fear. Present prices are firm.

PIG IRON PRICES

PITTSBURGH.

(First Quarter.)

Bessemer, valley	$17.25
Bessemer, Pittsburgh	18.15
Basic, valley	16.50
Basic, Pittsburgh	17.40
No. 2 foundry, valley	17.50
No. 2 foundry, Pittsburgh	18.40
Malleable, valley	17.25 to 17.50
Malleable, Pittsburgh	18.15 to 18.40
Gray forge valley	16.00 to 16.50
Gray forge, Pittsburgh	16.90 to 17.40

CHICAGO.

	First quarter.	First half.
Lake Superior charcoal	$18.75	$18.75
Northern foundry No. 2	18.00	18.00
Southern foundry No. 2	18.35	18.85
South'n silveries, 5 per cent sil.	.....	19.85
Jackson co. silv'ries, 8 per cent	21.90	22.40
Malleable Bessemer	18.00	18.00
Alabama basic	.....	18.85

CLEVELAND.

(First Half.)

No. 1 foundry	$18.25 to 18.75
No. 2 foundry	17.75 to 18.00
No. 2 southern	18.35 to 18.85
Bessemer	18.15 to 18.40
Lake Superior charcoal	19.10 to 19.75
Silveries, 8 per cent silicon	21.55
Bessemer ferro, 14 per cent	29.55

CINCINNATI.

	Spot shipment.	First quarter.
South'n No. 2 fdy.	$16.75 to 17.25	$17.25 to 17.75
South'n No. 3 fdy.	16.25 to 16.75	16.75 to 17.25
South'n No. 4 fdy.	16.00 to 16.50	16.50 to 16.75
South'n gray forge	15.75 to 16.25	16.25 to 16.75
Mottled	15.75 to 16.25	16.00 to 16.75
North'n No. 2 fdy.	17.70 to 18.20	18.20
North'n No. 3 fdy.	17.20 to 17.70	17.70
North'n No. 4 fdy.	16.95 to 17.45	17.45

PHILADELPHIA.

Eastern Pa. No. 1X foundry	$18.75 to 19.00
Eastern Pa. No. 2X foundry	18.50 to 18.75
Eastern Pa. No. 2 plain	18.25 to 18.50
Standard forge (Eastern Pa.)	17.50 to 17.75
Basic (Eastern and Central Pa.)	18.00 to 18.25
Virginia No. 2X	18.65 to 18.80
Southern No. 2	18.00 to 18.50
Malleable	19.50 to 20.00
Low phosphorus, Philadelphia	24.00 to 24.50

NEW YORK.

Northern foundry No. 1	$18.75 to 19.00
Northern No. 2X foundry	18.50 to 18.75
Northern No. 2 plain	18.25 to 18.50
No. 2 Virginia	18.80 to 19.00
No. 2 southern foundry	18.50 to 18.75
Malleable	19.50 to 20.00
Gray forge	17.50 to 17.75

Lake Michigan Ore Receipts

Owing to the increasing consumption of ore at Gary and other plants built in recent years, Lake Michigan is growing in importance in ore receipts. During 1910, Lake Michigan ports received a total of 7,452,084 gross tons. During 1911, which was of course a year of greatly decreased movement generally, Lake Michigan received 5,558,458 tons. During 1912 it received 8,357,070 tons, distributed as follows:

Port.	Gross tons.
Elk Rapids, Mich.	47,947
East Jordan, Mich.	42,878
Milwaukee, Wis.	138,065
Gary, Ind.	2,088,327
Indiana Harbor, Ind.	514,748
South Chicago, Ill.	5,480,105
Boyne City, Mich.	45,000
Total	8,357,070

BEST IN YEARS

Was Past Season For Bulk Freighters—Profits Not High.

Lake vessel owners engaged in the bulk freight trade have taken a reckoning of the season's business and find that it is the best that they have enjoyed for several years past. It would not, however, have been a profitable season had it not been for a number of contributory causes, the principal one being the unusually heavy movement of grain at very satisfactory rates. If the independent fleets had been compelled to depend upon ore, none of them would have earned any money, as even the larger class of carrier has to have excellent dispatch to do much more than break even at 40 cents. The movement of grain, however, was phenomenal and the vessels that were free to engage in it reaped a harvest. The leading independent fleets have declared dividends ranging from 7 to 10 per cent, but some of the smaller independent fleets that were without trade connections did not earn a dividend.

The advance of 5 cents in carrying charges on ore which is to go into effect next season will make it possible for the more active independent fleets to earn a little money in the ore trade, but will not enable them to declare such dividends as the hazard of the business warrants. Support will have to come from collateral trades to declare a good return upon the investment. However, conservative men in the business are quite content to let the advance in the ore rate remain 5 cents, as it seeks to discourage the speculative investor. There is no field offering in lake trade for the promoter at present.

The general feeling among vessel owners is one of contentment and of hopefulness. They are looking forward to several years of good business and do not believe that any legislative program can disturb it.

Will Make Steel Castings

The Standard Casting Co. has been incorporated under Ohio laws with a capital stock of $100,000 and will locate in Cleveland. The company will make a specialty of manufacturing small steel castings. Plans are now being considered by officials of the company to take over the plant of the Superior Drop Forging Co., West Seventy-third street and the Big Four railroad, which has been idle for some time. The company expects to begin operations within several months. Julius F. Janes, formerly treasurer of the Morgan Lithograph Co., will be president of the new company. Other officers are: Charles Harris, New York, vice president; S. C. Cutler, treasurer; R. M. Calfee, secretary; John H. Davis, formerly superintendent of the steel foundry of the Otis Steel Co., Cleveland, general manager.

WATER TRANSPORTATION

And Handling of Ore by Minnesota Roads to be Investigated.

The Interstate Commerce Commission has decided to investigate the business of water transportation on oceans, lakes and rivers and will hereafter require every water carrier engaged in interstate commerce to make a complete report as of Jan. 1, each year, similar to the reports now furnished by the railways. Blanks for that purpose have been forwarded to the various transportation companies.

The Interstate Commerce Commission has also decided to make an investigation into the handling of ore by the railroads which deliver the ore at the head of the lakes. It is asserted that certain rates, rules and regulations have been the subject of complaints to the commission. The order does not specify when the hearing is to be held because the commission has not yet formulated the data that it has on hand. Examiners for the commission have collected considerable information by correspondence.

TEN MILLIONS

Will be Spent by the Northern Pacific for Equipment.

Chicago, Dec. 31.—It is officially announced that the Northern Pacific will spend $10,000,000 for equipment for delivery next year. Rolling stock to be constructed includes 4,000 box cars, 2,625 refrigerator cars, 1,000 gondolas, 250 stock cars, 200 ore cars, 500 flat cars, 300 automobile cars and 60 tank cars.

This does not refer to any new authorizations by the board. It includes equipment authorized two months or so ago when President Elliott was in New York and also some odds and ends of orders authorized at previous meetings of the board this calendar year. Announcements regarding these matters have been made from time to time.

HUGE ENGINES

Inspected by Engineers at Mesta Works—See New Types.

Members of the Engineers' Society of Western Pennsylvania and scores of others visited the Mesta Machine Co.'s works, West Homestead, Pa., Saturday afternoon, Dec. 28, to inspect a twin tandem compound reversing engine, built for the Youngstown Sheet & Tube Co., Youngstown, O., and a direct flow steam engine, built for the power plant of the Carnegie Institute of Technology, Pittsburgh.

A special train left Pittsburgh at 2 o'clock and visitors remained at the plant until 5:30. The Youngstown engine is considered one of the most powerful rolling mill engines ever built and will operate a 44-inch blooming mill. The engine has two high pressure cylinders, 46 inches in diameter, 60-inch stroke, and two low pressure cylinders, 76 inches in diameter, 60-inch stroke. This engine was built for a steam pressure of 175 pounds and can be operated at 200 revolutions per minute. When running at 175 pounds steam pressure and 200 revolutions per minute, the engine will develop 35,000 horsepower.

The blooming mill engine weighs approximately 1,600,000 pounds, and about 16 special cars, known as gun trucks, will be required to carry it to Youngstown. The two bed plates each weigh about 240,000 pounds, and the shaft alone weighs approximately the same amount as one of the bed plates.

The direct flow engine, to be shipped to the Carnegie Institute of Technology, stood on the erecting floor, near the twin tandem engine. The direct flow engine will be direct-connected to a 500-kilowatt generator. This is a new type of prime mover for this country, although engines of similar design are being built in Germany.

Pig Iron Sales at Pittsburgh

Pittsburgh, Dec. 31.—A leading foundry in this city has closed for 2,000 tons of No. 2 foundry for delivery during the first half of the year at $17.50, valley, and for the same tonnage of charcoal iron for the same delivery at $25, Birmingham.

Another interest in this district has closed for 1,000 tons of Bessemer pig iron at a price reported to be slightly under $17.25, valley, for first half shipment. A number of inquiries for small lots of all grades are being received.

By-product coke plant of Coal Products Mfg. Co., Joliet, Ill.

New Koppers Oven Installation at Joliet, Ill.

THE SUPERIOR economy of by-product coke oven plants for steel works which have a large daily consumption of fuel and gas is well-recognized. This, however, does not represent the limit of their usefulness to the industry. The developments of the last few years have proved that by-product ovens may also be operated profitably to furnish foundry and metallurgical coke to the trade, at the same time utilizing the gas for domestic consumption or for industrial purposes.

An interesting installation of this type has been completed recently at Joliet, Ill., by the Coal Products Mfg. Co. The plant consists of 35 Koppers improved by-product coke ovens with the necessary auxiliary apparatus, having a daily capacity of approximately 450 tons of foundry coke and 3,550,000 cubic feet of illuminating gas, together with the customary quantities of tar and ammonium sulphate. The foundry coke is being marketed by Hickman-Williams & Co., Chicago and Cincinnati, and the gas is distributed for domestic purposes among a large number of towns in the vicinity of Joliet. The plant was designed and built under the supervision of H. Koppers Co., Chicago. The ovens are of the standard Koppers combination, cross-regenerator type, but have a number of improved features, including self-sealing doors and water-cooled stand pipes. An improved gas and air reversing mechanism has been installed and a new type of charging car is used on the top of the ovens. Arrangements are made for separating the rich from the lean gas and the ovens are designed for an 18-hour coking period. Special attention has been paid to the coke quenching, screening and shipping apparatus.

The plant is situated on the south side of the Chicago drainage canal about three miles north of Joliet. It occupies a plot of ground approximately 1,000 feet long and 700 feet wide. There is a direct connection with the Elgin, Joliet & Eastern railway, which in turn con-

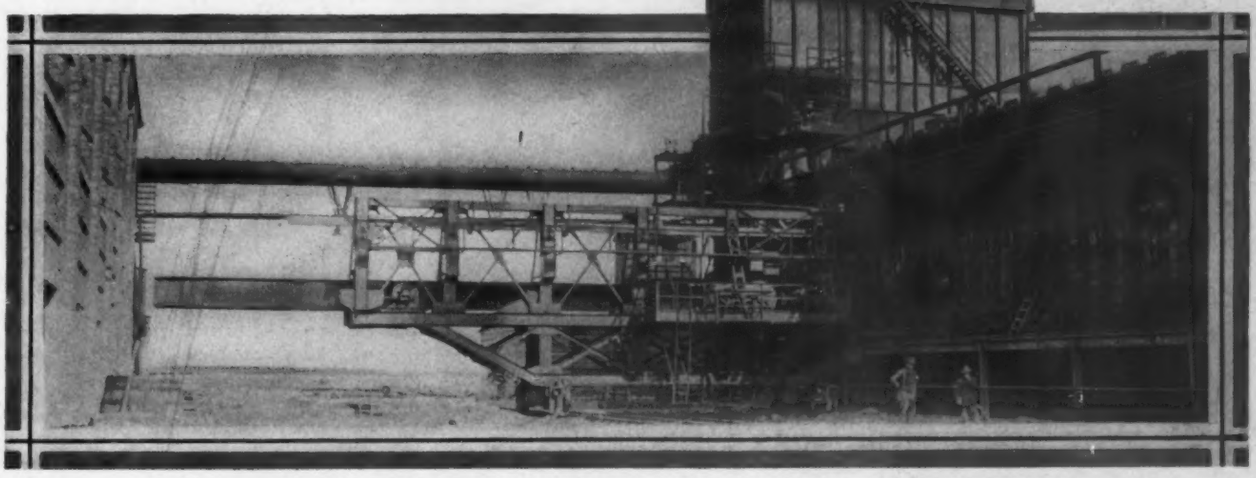


FIG. 1—PUSHING AND LEVELING MACHINE WITH COAL HOUSE IN THE BACKGROUND

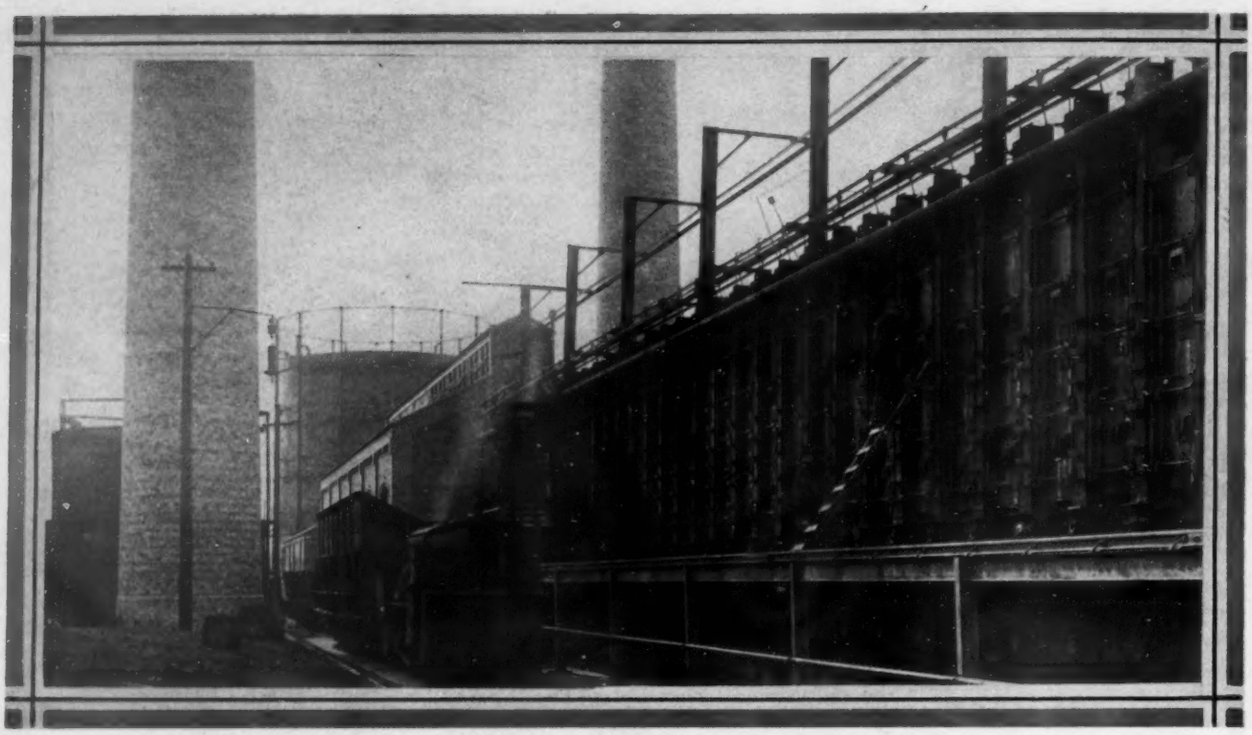


FIG. 2—FRONT SIDE OF OVEN, SHOWING STACKS AND GAS TANKS IN THE BACKGROUND

nects with all of the railroads entering Chicago. The general arrangement of the plant, including the coal and coke storage and trackage facilities, is shown in Fig. 6. As previously mentioned, the plant contains 35 ovens at present, but it is the intention of the Coal Products Mfg. Co. to double this capacity as soon as business conditions warrant, and the works have been laid out with this end in view. The additional 35 ovens will be built north of the present group so that the coal bin will eventually be between the two batteries instead of at the north end of one. The coal handling and by-product apparatus is designed for an ultimate installation of 70 ovens.

General Layout

The general layout of the plant, as indicated in Fig. 6, is compact and simple. The coal and coke storage yards are on the eastern edge of the property and occupy a strip 1,000 feet long and 150 feet wide. Between them and the ovens is a space 175 feet in width occupied by the coal handling and coke shipping apparatus together with the necessary railroad tracks. The center line of the oven battery extends in a northeast and southwest direction parallel to the coal and coke storage yards. The battery of ovens now in service is approximately 200 feet in length and 40 feet in width exclusive of pusher foundations. The engine and boiler house is placed immediately south of the coke ovens and the machine shop is situated in a separate building south of the power house. The by-product plant is located west of and parallel to the oven battery. The tar tanks and primary coolers are at the north end of the by-product building, while the dryers and sulphate storage rooms are at the south end. The by-product building is 260 feet long and 54 feet wide.

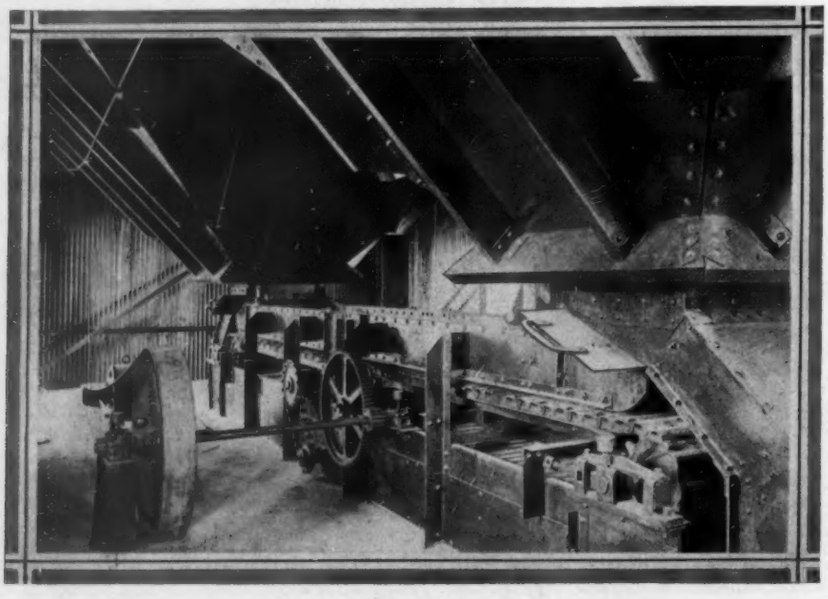


FIG. 3—THE COAL MIXER

Coal Storage Yard

The general arrangement of the coal storage yard is indicated in Fig. 6. The yard is 350 feet long and 150 feet wide, having a capacity for the storage of a two months' supply. A transfer bridge of the usual type with a span of 150 feet operates over the coal yard. This storage is provided for emergency use only, in order that the plant may continue in operation through any ordinary interruption of coal shipments. Under the usual conditions, the shipments of coal are unloaded and consumed as fast as they are received. An area 500 feet long and 150 feet wide has been set aside north of the coal yard for coke storage. This space is served by the

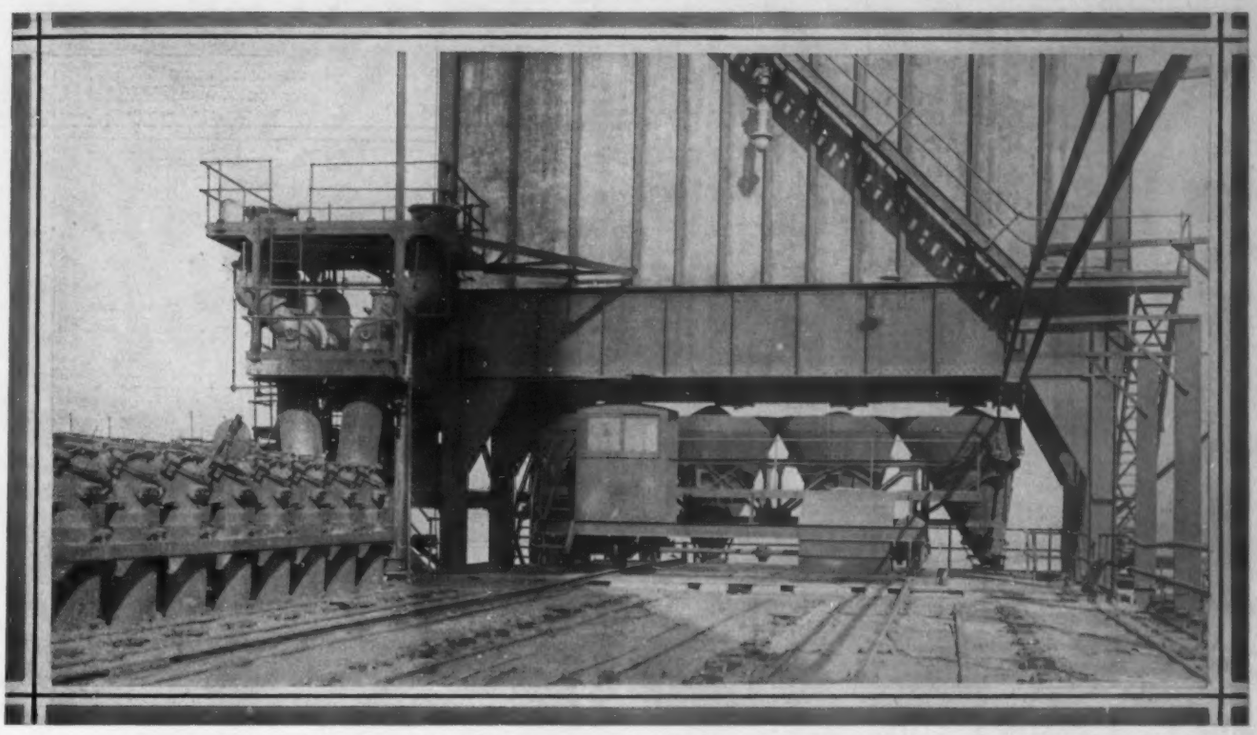


FIG. 4—TOP OF BATTERY, SHOWING LARRY USED IN CHARGING THE OVENS

same traveling bridge that is used for coal handling.

The coal handling and storage plant was constructed by Heyl & Patterson, Pittsburgh, and the handling facilities are arranged for a prepared coal output of 1,200 net tons per day of eight hours. Provision has been made for receiving and treating separately two kinds of coal and for mixing these coals in any desired proportions. The prepared coal is reduced to such fineness that from 80 to 85 per cent will pass through a ⅛-inch mesh screen.

Coal Breakers

Referring to Fig. 6, run-of-mine coal received in bottom dump cars is deposited in the concrete receiving hoppers and is passed by an apron feeder to the belt conveyor leading to the breaker. This conveyor extends through an inclined gallery to the top of the breaker and crusher building and delivers the coal directly to the Bradford breaker. The refuse from the breaker is passed through a chute to the refuse bin, which is provided with gates for discharging the refuse into railroad cars. The breaker-treated coal is gathered by a hopper and is passed through a magnetic separator to the crusher. The product of the crusher is delivered to belt conveyor No. 2, which connects the breaker building with the mixing and storage bins situated at the north end of the ovens. There are two mixing bins, one for each kind of coal, with a capacity of 100 tons each. The coal is drawn from these bins by two feeders, Fig. 3, so arranged that the quantity from each can be adjusted to any desired proportion. From the feeders the coal passes through a mixer and drops into a 400 ton capacity storage bin from which the oven larries are filled. Provision has also been made for by-passing the coal from the mixing bins around the mixer equipment to the larry bin.

The breaker and crusher house is 40 feet long and 20 feet wide; its center is located 214 feet south of the center line through the coal bin columns. The equipment in the breaker building is arranged in the usual manner with the Bradford breaker on top and the hammer mill crusher beneath, the magnetic separator being placed between these two units. The breaker runs about 12 revolutions per minute and is motor-driven. The magnetic separator consists of a short belt conveyor provided with a magnetic head roll which holds the iron on the belt until it passes the point of coal discharge. As soon as the metal leaves the magnetic field it is dropped into the chute. The crusher is of the standard swing hammer type designed to reduce the coal until 80 to 85 per cent will pass through a ⅛-inch

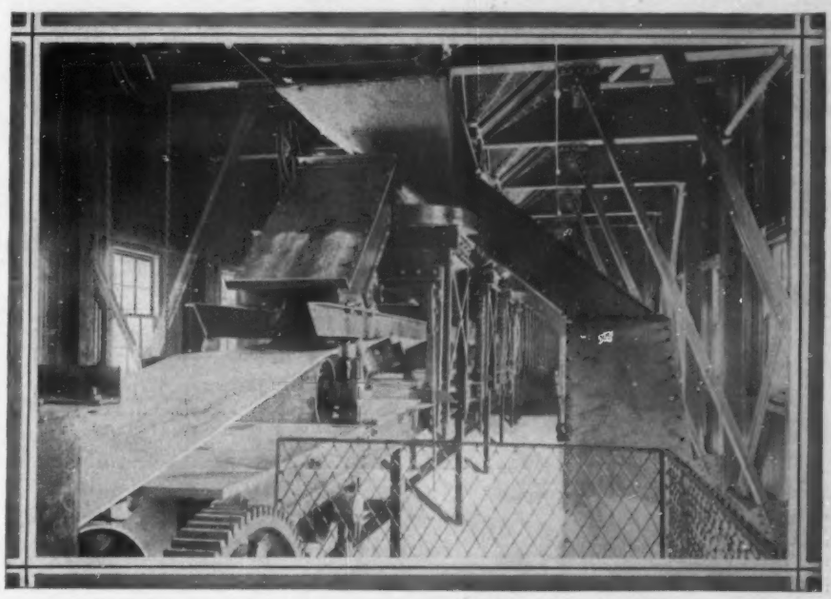


FIG. 5—BELT CONVEYOR FROM THE BINS IN THE COKE STORAGE BUILDING

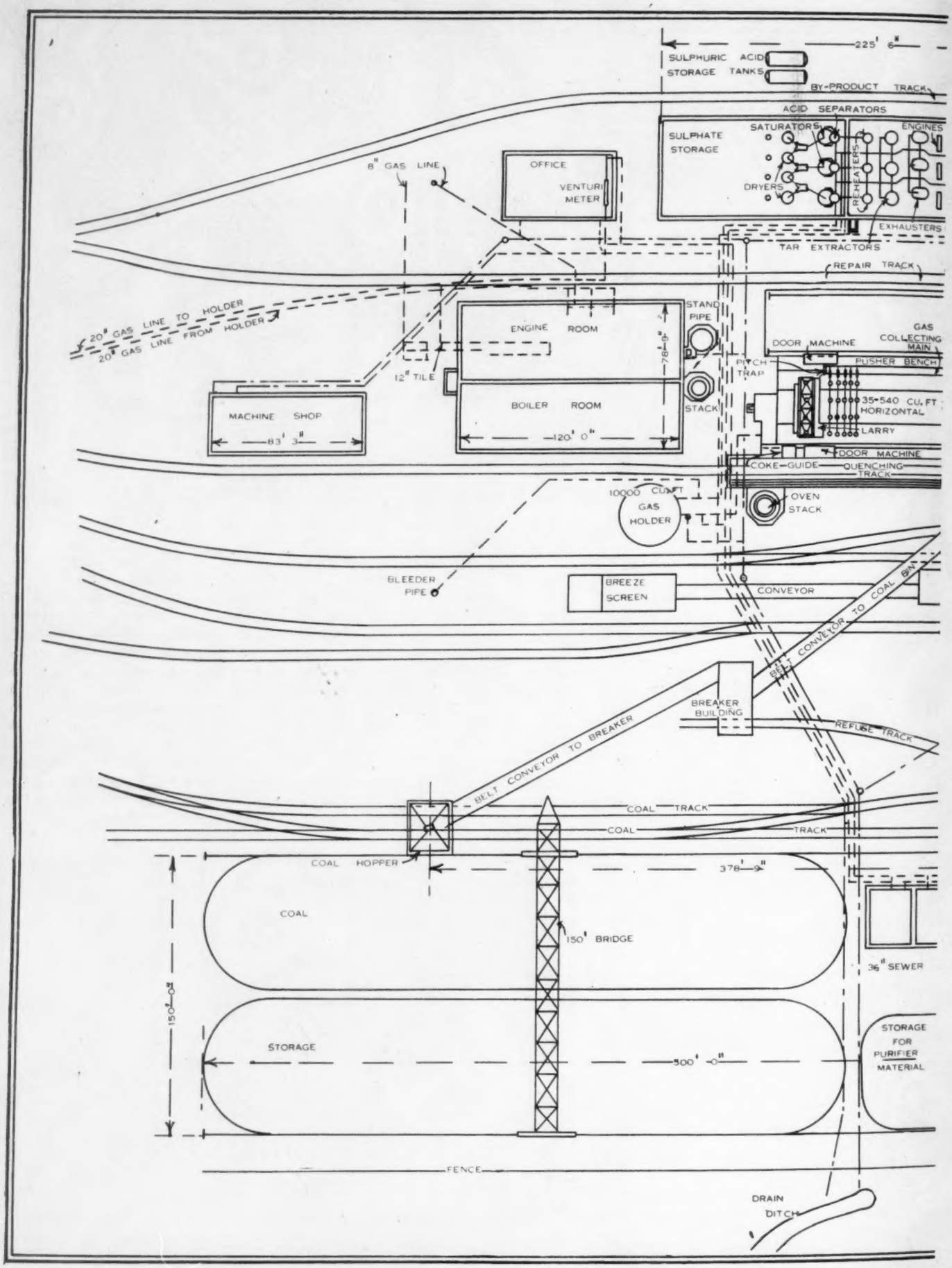
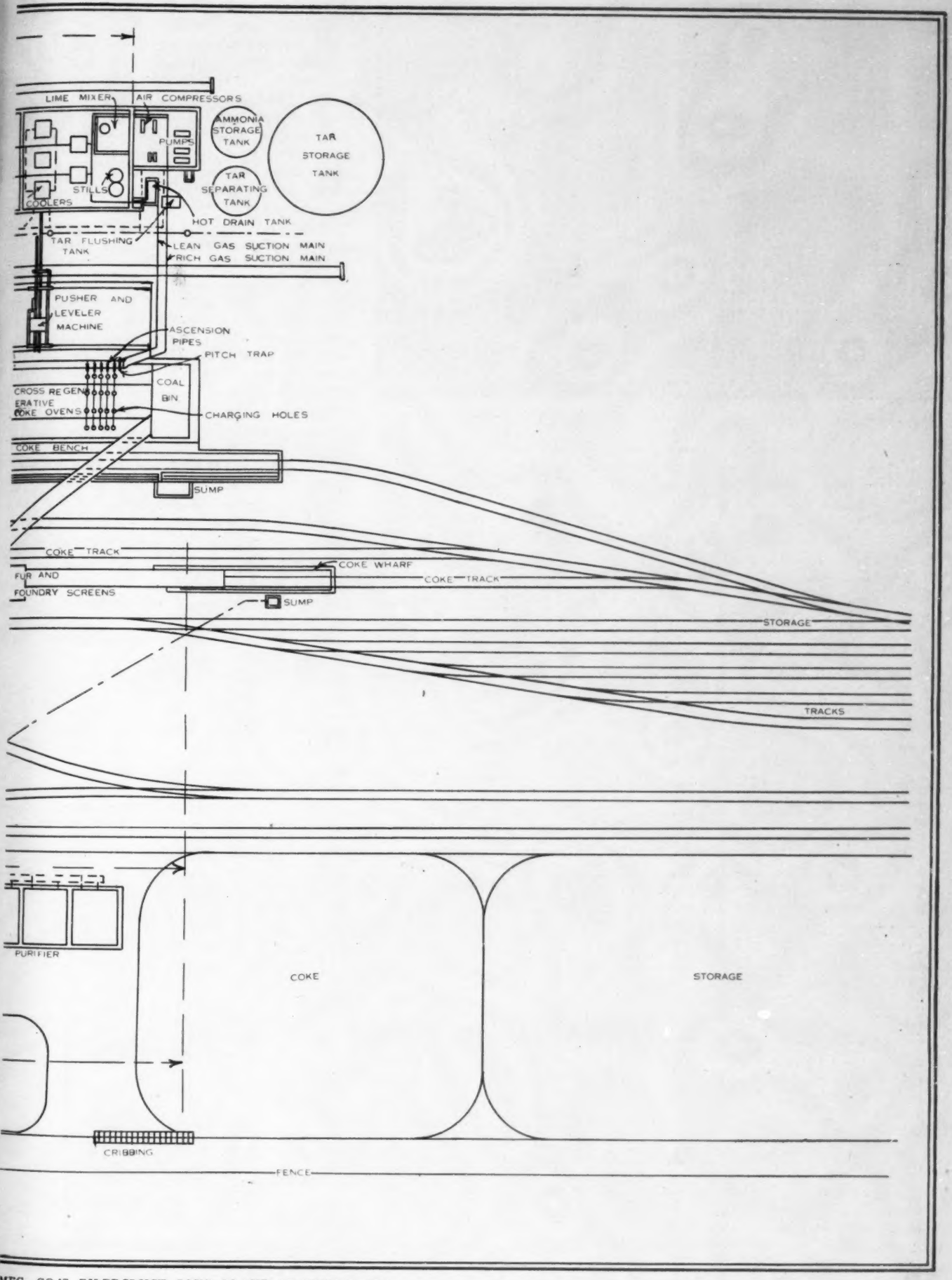


FIG. 6—GENERAL ARRANGEMENT OF THE COAL PRODUCTS



MFG. CO.'S BY-PRODUCT COKE PLANT AT JOLIET, ILL.

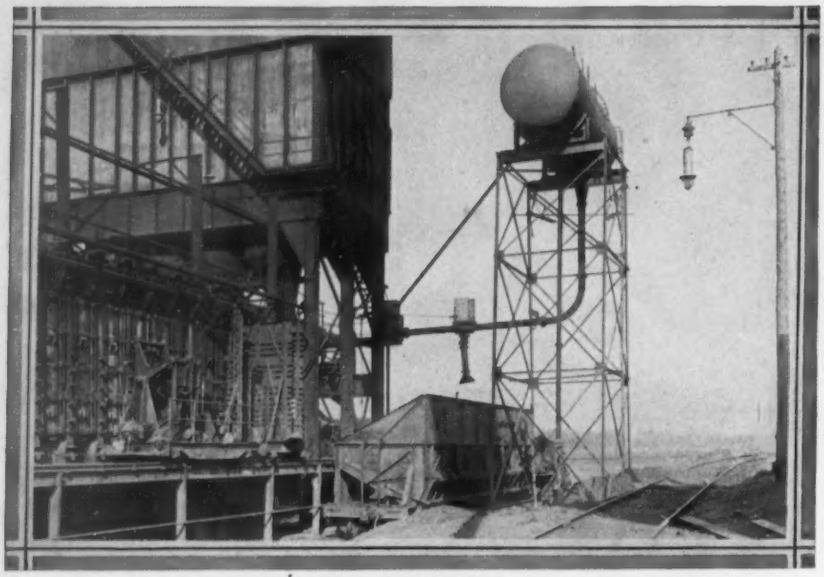


FIG. 7—QUENCHING STATION AND DOOR-EXTRACTING MACHINE

mesh. Under the crusher is a steel hopper that discharges the coal onto the belt conveyor leading to the mixing bins. The crusher is operated by a 125-horsepower electric motor.

An exterior view of the mixing and storage bins is shown in Fig. 1, while Fig. 3 illustrates the details of the coal mixer. The bins have 4½-inch reinforced concrete walls and are fitted with steel plate hoppers at the bottom. The general arrangement of the coal handling apparatus is compact and simple. The length of the necessary belt conveyors has been reduced to a minimum while the arrangement of the mixing and larry bins under one roof resulted in considerable ecomonies in construction. Each of the two belt conveyors has a capacity of 150 tons per hour.

The Koppers Ovens

The ovens are of the standard Koppers' cross-regenerator type, the principal features of which were described in THE IRON TRADE REVIEW, August 11, 1910, and January 5, 1911. As previously stated, the ovens are provided with a number of interesting improvements. The oven chambers are 39 feet long by 11 feet high, tapering from 18½ inches to 21 inches in width. Each oven has a capacity of 13.7 net tons of coal. The general arrangement of the oven battery is indicated in Figs. 1, 2 and 7.

Special attention should be called to the improved self-sealing oven doors which have been installed at the Joliet plant. The doors are designed so that they seat on a water-cooled pipe, an asbestos gasket being used to make a tight joint. With this type of door, no clay luting is necessary and it is a matter of only a few moments either to extract or reseat the door. The door extracting and reseating machine, which is carried along the front of the ovens by a small electrically-driven larry, is illustrated in Fig. 7.

The wire cables which operate the gas and air reversing valves, instead of being wound on drums geared to the reversing motor, are attached to levers which are in turn operated by a heavy chain passing over two large sprockets situated at the south end of the battery. One of the sprockets is driven by the reversing motor through a worm gear. The arrangement is simple and is claimed to be more efficient for a battery of this size than the drum type mechanism.

A general view of the top of the ovens showing the gas connections and the charging larry is shown in Fig. 4. The gage of the larry track is 18 feet.

The design of the larry car itself shows a considerable advance over the earlier types. The car carries four independent conical steel hoppers, each of which distributes its quota of coal into the ovens through the proper charging hole. The sides of the hoppers are very steep so that the coal has no tendency to stick.

The stand pipes are fitted with water-cooled jackets, which promote tar condensation, thus keeping the pipes clean of carbon. The gas is collected in a divided, tar-sealed main which is arranged to separate the rich gas from the lean. This is accomplished by a pair of butterfly valves communicating with each stand pipe. The rich gas obtained during the first 10 hours of distillation is delivered into one side of the collecting main; at the end of this period, the valves are reversed so that the lean gas goes into the opposite part of the main. The main is provided with a mechanical tar scraper. The rich and lean gas is delivered to the by-product building through separate pipes as indicated in Fig. 2.

Pushing and Leveling Machine

The ovens are pushed and leveled by a combined pushing and leveling machine, Fig. 1, furnished by the Alliance Machine Co., Alliance, O. The entire machine is carried on a track having a gage of 30 feet, along which it is capable of moving at a rate of from 250 feet to 300 feet per minute. The rams are supported by the frame on rollers and are arranged to be moved in and out by electric power. The rollers which carry the leveler ram are so connected to the structural frame of the

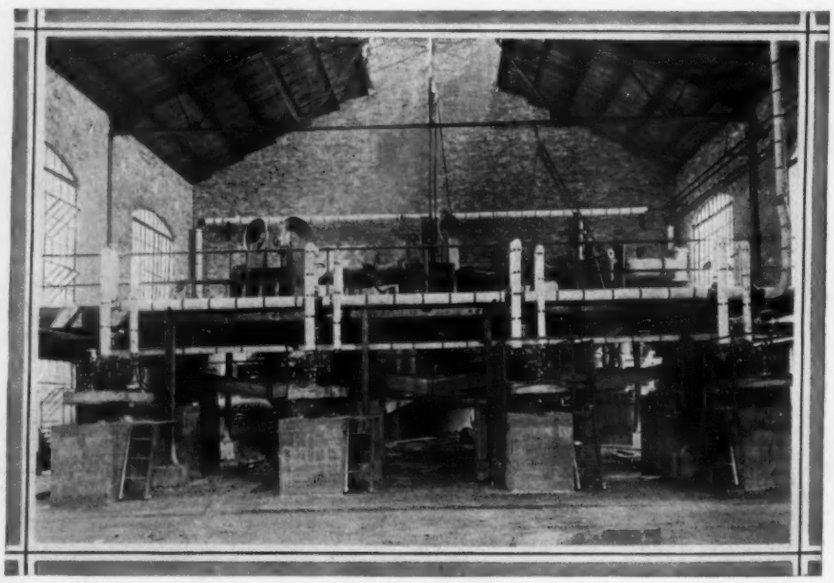


FIG. 8—CENTRIFUGAL DRYERS WITH SATURATORS IN THE REAR

machine as to allow a vertical adjustment of about 2 inches. The backward and forward movement of the leveler bar is controlled automatically by means of trips.

When coking is completed and the gas fully driven off, the doors of the oven are removed and the charge is pushed out into a quenching car on the track which extends in front of the ovens. The general arrangement of the quenching car, which was furnished by the Kilbourne & Jacobs Mfg. Co., Columbus, is shown in Figs. 7 and 10. The car is supported on two standard M. C. B. four-wheel trucks, the wheels being 33 inches in diameter. The body of the car is 40 feet long inside and 12 feet in width, its coke capacity being approximately 10 tons. The bottom is inclined to one side at an angle of about 30 degrees. A set of four discharge gates, which are operated in pairs either by hand or air pressure, are provided, and when the gates are opened the load in the car slides out without assistance. The car is handled by a small switching locomotive. As soon as the charge of coke from the oven is entirely loaded into the car, it is rushed to the quenching station and is cooled by means of a heavy stream of water.

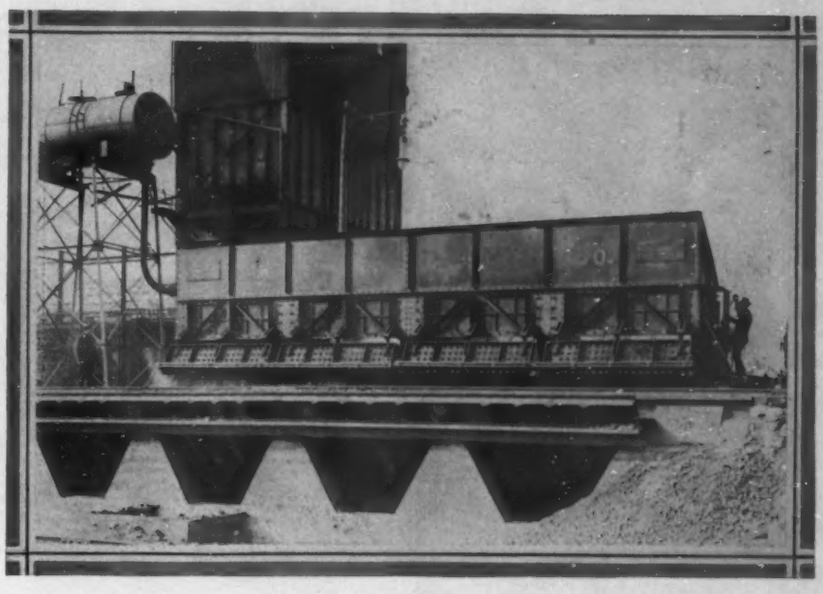


FIG. 10—QUENCHING CAR DISCHARGING LOAD INTO COKE RECEIVING HOPPER

Quenching Station

The arrangement of the quenching station is shown in Fig. 7. It consists of a cylindrical tank with a capacity of 10,000 gallons mounted on a high structural frame and connected with the quenching spray by a 10-inch pipe. The tank being filled, the spray valve is opened and the carload of red hot coke is passed under the stream of water three times, allowing 40 seconds for each pass. The total time required to quench a carload of coke is, therefore, 120 seconds. When quenching is complete the spray valve is closed and the tank is refilled by a pump.

The quenched coke is dumped into a series of steel, cast iron-lined receiving hoppers, as illustrated in Fig. 10. The location of these hoppers is shown in Fig. 6, in which they are marked *coke wharf*. The hoppers discharge the coke onto a feeder from which it is passed to a belt conveyor extending to the furnace and foundry coke screens. These are located in a separate building situated in front of the ovens, as indicated in Fig. 6. All coke of foundry and furnace size is screened out at this point and chuted into cars for shipment. A second conveyor carries the remainder of the coke to the domestic coke screening station where it is again screened and separated into various sizes for domestic and industrial use.

FIG. 9—THE BOILER PLANT

By-Product Recovery

The gases from the ovens are passed to the by-product plant through two 30-inch mains, one being used for the rich and the other for the lean gas. The details of the by-product portion of the Koppers process have been fully described in previous issues of THE IRON TRADE REVIEW, the principal feature of the system being the direct recovery of ammonium sulphate from the gas. The by-product plant at Joliet includes a cooler and still room 60 feet long, an exhauster and reheating room also 60 feet long and a saturator and sulphate storage room 100 feet long, the total length of the by-product building being 225 feet and its width is 54 feet. The air compressors and pumps are situated in a room 32 feet square, located at the north end of the by-product plant. The general arrangement of the entire department is indicated in Fig. 6. There are three units throughout, one set being used for handling the rich gas, another for the lean gas, while the third is reserved as a spare. North of the by-product building is a tar storage tank with a capacity of 282,879 gallons, together with two tar separating and ammonia storage tanks, each 25 feet in diameter. The sulphuric acid is stored in two horizontal cylindrical tanks placed alongside of the track west of the by-product building. Each acid tank has a capacity of 7,150 gallons.

The gas from the ovens on reaching

FIG. 11—PUMP ROOM IN THE BY-PRODUCT BUILDING

the by-product plant first enters a five-pass tubular cooler, emerging at a temperature of about 30 degrees Cent. Three coolers have been installed, one being used for the rich gas and one for the lean gas, while the third is held as a spare. Space, however, is provided for the installation of two more coolers, which will be added when the 35 additional ovens are built. The tar collected from the system passes into the separating tanks in which the weak ammonia liquor is removed. The liquor is stored in the ammonia storage tank and twice a week is converted into ammonia vapor in the two stills which are provided for this purpose. This ammonium vapor passes into the gas main and is absorbed in the saturators. The tar is circulated by double acting steam pumps, Fig. 11, installed in the pump room.

The Steam-Driven Exhausters

From the primary coolers the gas is drawn through steam-driven exhausters. These machines were furnished by the Connersville Blower Co., Connersville, Ind. From the exhausters, the gas passes through extractors, reheaters and saturators. The three saturators deliver the ammonium sulphate into four steam-driven, centrifugal dryers, Fig. 8, from which it is removed in hand buggies and stored in piles awaiting shipment. Only three men are used in the by-product department, one in the sulphate room, one to handle the machinery in the exhauster room and one in the pump room. On a 24-hour coking period the plant can be arranged to run day time only, as far as charging and pushing the ovens is concerned.

The rich gas after leaving the by-product building passes through purifiers situated between the coal and coke storage yards and from thence into a holder of 2,000,000 cubic feet capacity. The lean gas, which is used to heat the ovens, passes directly from the by-product building to the small gas holders shown behind the chimney in Fig. 2. This holder has a capacity of 10,000 cubic feet.

Power Station

The electric power used by the plant is generated by three direct-connected units, Fig. 13, one being held as a spare. Each unit comprises a 340-horsepower Lentz poppet valve steam engine, built by the Erie City Iron Works, Erie, Pa., and a 250-kilowatt, 250-volt, 1,000-ampere direct current Westinghouse generator. The power is distributed through a 10-panel switchboard. The engine runs condensing.

The power plant also includes three gas compressors, which are used to compress the gas to 40 pounds per square inch for delivery to the 8-inch mains leading to the various points of consumption. These compressors are of the cross-compound condensing type, the steam cylinders being 14 and 24 inches in diameter by 16-inch stroke, and the air cylinders 17 inches in diameter and 16 inches stroke. Two rotary blowing units for furnishing gas to the low pressure distribution system in the city of Joliet are also installed. One of the units consists of a 25-horsepower, 230-volt direct current motor coupled to a Connersville blower of 4.2 cubic feet capacity per revolution, and the other unit includes a blower of the same capacity connected to a 7½-horsepower motor. The set with the smaller motor is used as a spare.

Boiler Installation

Steam for the various engines is generated in four Erie City vertical water tube boilers, Fig. 9. The boilers have a capacity of 300 horsepower each and are equipped with Foster superheaters. They are hand-fired with coke breeze.

Operating on an 18-hour coking period, this plant will produce 475 net tons of coke per day, requiring 640 tons of coal, the coke yield being 74 per cent. At the present time a coal mixture including 35 per cent Pocahontas coal and 65 per cent Pittsburgh coal is used. The Pocahontas coal contains 15 to 16 per cent volatile matter and the Pittsburgh coal 33 per cent. The gas production, which is approximately 10,000 cubic feet per ton of coal, will be 6,400,000 cubic feet per day when operating with an 18-hour coking period. Of this total 3,520,000

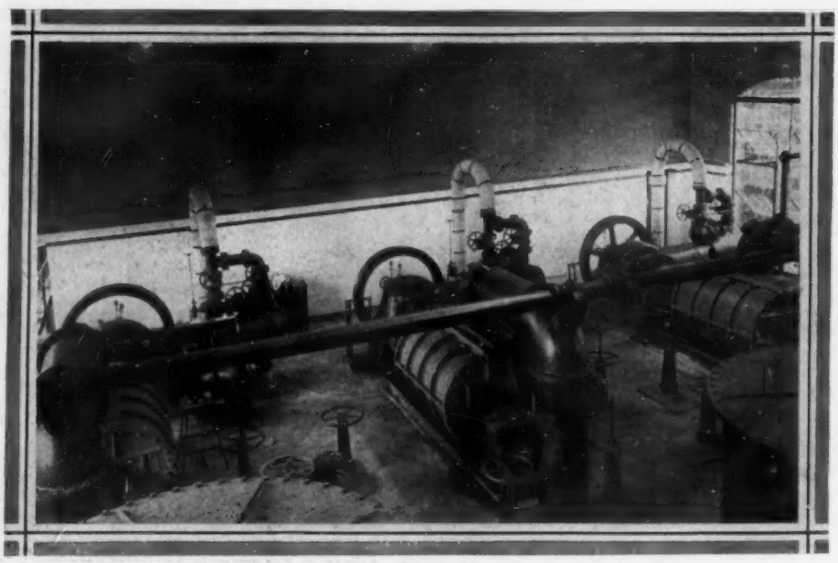


FIG. 12—EXHAUSTERS IN THE BY-PRODUCT DEPARTMENT

cubic feet or about 55 per cent of the gas is sufficiently rich for illuminating purposes. About 3,300 gallons of tar will be reclaimed daily, together with 14,000 pounds of ammonium sulphate, the latter being from 20 to 25 pounds per ton of coal. The quality of the surplus gas from the above coal mixture is such that it is used for illuminating purposes without enrichment.

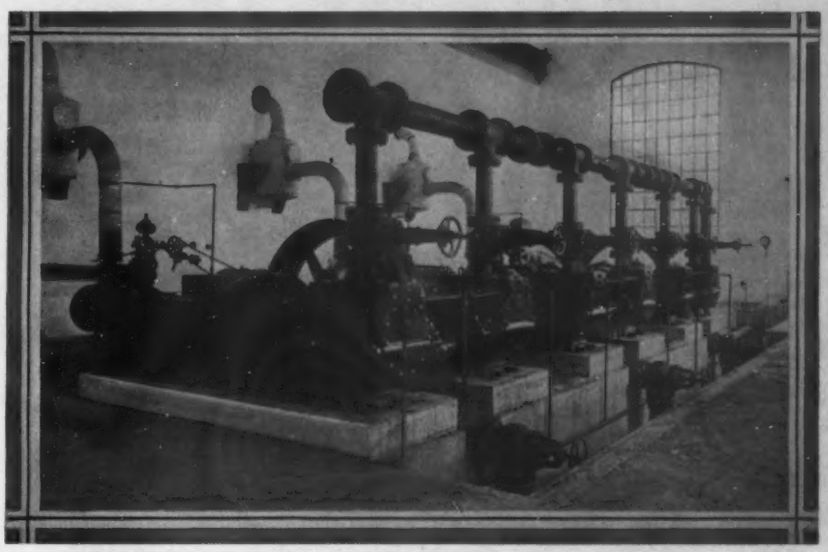


FIG. 14—COMPRESSORS DELIVERING GAS TO THE HIGH PRESSURE DISTRIBUTING SYSTEM

Iron Ores of Alabama

The iron ores of Alabama, in the order of their economic importance, according to Eugene A. Smith, state geologist of Alabama, are (1) red ore or hematite; (2), brown ore or limonite, and (3), gray ore. The most important development of the Clinton, or red ore, in Alabama, is along the 15 or 16-mile stretch of the east Red mountain, between Birmingham and Bessemer, Ala., and there is practically a continuous series of mines and strippings for this entire distance. Much mining of this ore has also been done near Gate City, Village Springs, Attalla, Gadsden, Round Mountain, Gaylesville, Ft. Payne, Valley Head, etc. In 1909, $1.07 was the average price per long ton of hematite ore in Alabama, and in 1910, $1.19 was the average. The state's production of hematite ore in 1909 amounted to 3,176,416 tons, which was 6.87 per cent of the total production of the United States for that year, and the value of which was $3,389,206. In 1910, these figures respectively were 3,678,139 tons, 7.12 per cent and $4,376,555.

The state holds first rank in the United States as a producer of limonite. To 1876, this was the only ore used in the catalan forges, bloomeries and charcoal furnaces of the state. In general, the limonites are considered the best of the ores of the state, commanding the highest prices and a ready sale. The ore usually occurs in irregular masses of concretionary origin, in the residual clays resulting from the decomposition of limestones, and for these reasons the mining is expensive and uncertain. When the ore occurs in stratified seams or beds, it is the result of alteration of pyrites or of carbonate ores. Practically all the ore mined is that occurring in the residual clays.

Before it is shipped to the furnace, the ore is washed and screened and this increases the total expense. Because of this cost, this ore is seldom used alone, but is mixed with the red ore in the proportions determined by the quality of iron desired. It is used alone in the charcoal and coke furnaces, when a particularly tough iron is desired. The limonite deposits are numerous; they are distributed over a broad expanse of country and in many places are known to be extensive. In some of the deposits the ore is in nearly a solid mass, but in others it is much scattered. As a result, the amount of foreign material that must be moved for every ton of ore produced differs greatly not only in the various ore banks but in different parts of the same bank. The average price per long ton of limonite in Alabama was $1.41 in 1909, and $1.53 in 1910. In those years respectively, 1,144,836 and 1,123,136 tons were produced, being 42.39 and 39.15 per cent of the total production of this variety of ore in the United States. The value of the production was $1,607,249 and $1,707,167.

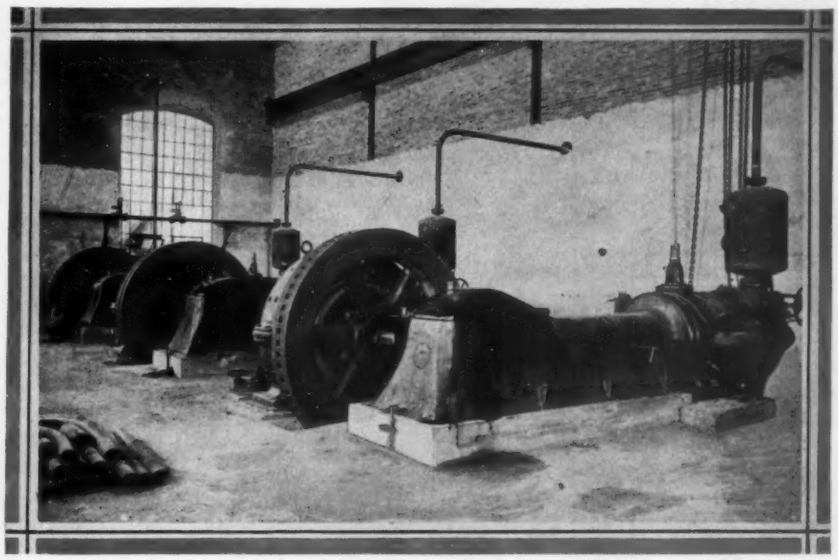


FIG. 13—DIRECT-CONNECTED ELECTRIC GENERATING UNITS

Record-Breaking Output of Copper

The year 1911 was one of prosperity for the copper industry, both smelter and refinery outputs being the largest in its history, according to a report issued by the United States geological survey.

The average price of copper for 1911 was 12.5 cents a pound, slightly below the price of 1910, but near the close of the year the price advanced, the average for December being 13.71 cents a pound. Metal market conditions continued to improve till the average price had risen, in July, 1912, above 17 cents a pound, the highest price since the panic of 1907.

The smelter production of copper in the United States in 1911 was 1,097,232,749 pounds, or 56 per cent of the world's production, and its value for 1911 was $137,154,092.

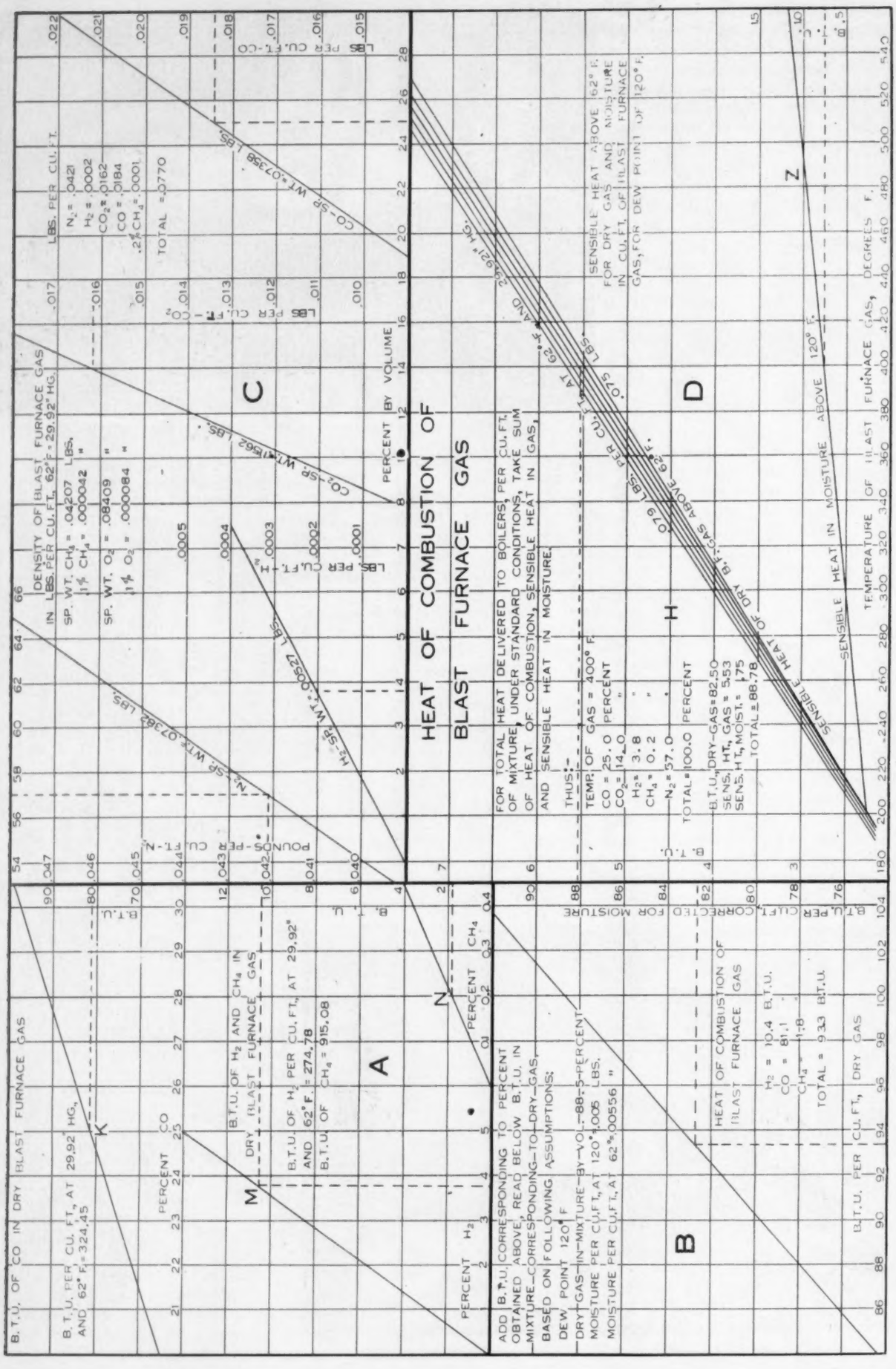

HEAT OF COMBUSTION OF BLAST FURNACE GAS
A
B
C
D
H
K
M
N
Z
PERCENT H2
PERCENT CO
PERCENT CH4
B.T.U. OF CO IN DRY BLAST FURNACE GAS
B.T.U. PER CU. FT., AT 29.92" HG., AND 62° F.= 324.45
B.T.U. PER CU. FT., DRY GAS
POUNDS PER CU. FT.-N
DENSITY OF BLAST FURNACE GAS IN LBS. PER CU. FT. 62° F. 29.92 HG.
LBS. PER CU. FT.
LBS PER CU. FT.-CO2
LBS PER CU. FT.-H2O
PERCENT BY VOLUME
B.T.U. OF H2 AND CH4 IN DRY BLAST FURNACE GAS
B.T.U. OF H2 PER CU. FT., AT 29.92" AND 62° F.= 274.78
B.T.U. OF CH4 = 915.08
ADD B.T.U. CORRESPONDING TO PERCENT OBTAINED ABOVE, READ BELOW B.T.U. IN MIXTURE—CORRESPONDING—TO—DRY—GAS, BASED ON FOLLOWING ASSUMPTIONS:
DEW POINT 120° F.
DRY GAS IN MIXTURE—BY—VOL.—88.5 PERCENT
MOISTURE PER CU. FT., AT 120°=.005 LBS.
MOISTURE PER CU. FT., AT 62°=.00556 "
B.T.U. CORRECTED FOR MOISTURE
FOR TOTAL HEAT DELIVERED TO BOILERS, PER CU. FT. OF MIXTURE, UNDER STANDARD CONDITIONS, TAKE SUM OF HEAT OF COMBUSTION, SENSIBLE HEAT IN GAS, AND SENSIBLE HEAT IN MOISTURE.
THUS:-
TEMP. OF GAS = 400° F.
CO = 25.0 PERCENT
CO2 = 14.0 "
H2 = 3.8 "
CH4 = 0.2 "
N2 = 57.0 "
TOTAL = 100.0 PERCENT
B.T.U. DRY-GAS = 82.50
SENS. HT. GAS = 5.53
SENS. HT. MOIST. = 1.75
TOTAL = 88.78
HEAT OF COMBUSTION OF BLAST FURNACE GAS
H2 = 10.4 B.T.U.
CO = 81.1 "
CH4 = 1.8 "
TOTAL = 93 B.T.U.
SENSIBLE HEAT IN MOISTURE ABOVE 120° F.
SENSIBLE HEAT OF DRY GAS ABOVE 62° F.
SENSIBLE HEAT ABOVE 62° F. FOR DRY GAS AND MOISTURE IN CU. FT. OF BLAST FURNACE GAS, FOR DEW POINT OF 120° F.
TEMPERATURE OF BLAST FURNACE GAS, DEGREES F.

FIG. 1—CURVES FOR OBTAINING THE HEAT OF COMBUSTION OF BLAST FURNACE GAS

Determining Heat Value of Blast Furnace Gas

How the Three Factors Necessary for Making Calculation Are Obtained by the Use of Curves

By J F Mowat

IN IRON and steel works using blast furnace gas as fuel it is advisable to make frequent boiler tests to keep an accurate check on the economy and efficiency of the steam generating apparatus. In conducting these tests it is necessary, among other things, to know the heat value of the gas, not the dry gas as determined by analysis, but the actual mixture of gas and water vapor as it enters the furnace. This involves the determination of three factors, namely, the heat of combustion of the dry gas in the mixture under standard conditions of pressure and temperature, that is, at 62 degrees Fahr. and 29.92 inches barometer; the sensible heat of the dry gas above 62 degrees Fahr. and the sensible heat of the moisture above the dew point of the gas.

Use of Curves for Determinations

To arrive at these quantities by analytical methods a rather lengthy calculation is involved and to avoid this the accompanying curves have been made. By the use of the curves the three factors mentioned in the foregoing paragraph may be determined graphically and the heat of combustion quickly computed.

Blast furnace gas is composed principally of carbon monoxide, hydrogen and methane, which are combustible gases, and carbon dioxide and nitrogen, inert gases. Each of the combustible gases when burned liberates a definite amount of heat per unit volume, for any given pressure and temperature. To find the heat available per cubic foot of raw blast furnace gas, we must start with the analysis of the dry gas and determine the heat of combustion. The amount of heat given off by each constituent of the dry gas as measured by different investigators, shows considerable variation. Those given by MacFarland have been used in the following calculations, as they are close to the average of the best known authorities. MacFarland gives 324.45 British thermal units per cubic foot as the heat of combustion of carbon monoxide, 274.78 as the value for hydrogen and 915.08 as that for methane.

The figures used are the *low* heat values. That is, in the combustion of gases containing hydrogen, steam is formed and its latent heat of vaporization is lost. When the products of combustion cool down below the boiling point, this steam condenses and its latent heat becomes sensible, being measurable in a calorimeter. Since in a boiler the stack temperature cannot be as low as the boiling point corresponding to the stack draft, condensation cannot take place while the waste gases are in the boiler. Consequently, it is not right to charge the boiler with the latent heat of the steam formed during combustion. For this reason the heat of combustion of the dry gas is assumed as the total heat of the gas burned at 62 degrees Fahr. and cooled down to 62 degrees Fahr., less the latent heat of the steam formed.

Accordingly, the heat available from a cubic foot of dry blast furnace gas under standard conditions may be found by multiplying the heat values of the constituent gases by the amounts shown in the analysis of the gas. The sum of these items gives the heat available per cubic foot of dry gas. This must be corrected for the space occupied by the moisture present to give the heat of combustion of a cubic foot of the mixture.

Finding Sensible Heat of Dry Gas

Having determined the volume of dry gas in a cubic foot of the gas as fired, the sensible heat of this dry gas above 62 degrees can be calculated from the initial temperature, the density and specific heat of the dry gas.

In the same way, the sensible heat of the moisture can be found. Here again the latent heat of the steam is disregarded, as there is no chance for the vapor to condense; therefore, the sensible heat is calculated to the temperature of the dew point of the gas. Observations have shown that in the case of raw, that is, unwasted blast furnace gas, the dew point does not, as a rule, vary much from 120 degrees Fahr. so it has been assumed constant at this figure.

It is now possible to consider the derivation and application of the curves given in Fig. 1. These curves are all straight lines, and are located by two points. Consequently, the derivation of the heat value in a single case will illustrate the method.

Derivation of the Curves

Assume a gas of the following analysis:

		Per cent.
Carbon monoxide.....	CO	25.0
Carbon dioxide.....	CO_2	14.0
Hydrogen	H_2	3.8
Methane.	CH_4	0.2
Nitrogen	N_2	57.0

The British thermal unit per cubic foot of dry gas as mentioned above, is the sum of the products of the heats of combustion of the constituent combustible gases and their percentages divided by 100. Therefore,

CO	324.45 × 0.250 =	81.11
H_2	274.78 × 0.038 =	10.44
CH_4	915.08 × 0.002 =	1.83
Total B. T. U. per cu. ft. at 62 deg. Fahr. and 29.92 in. barometer =		93.38

Each of the above figures gives a point on the curve for the corresponding gas. Referring to the group of curves, *A*, Fig. 1, the factor for the combustion of carbon monoxide is found by erecting an ordinate on the 25 per cent line intersecting the CO curve at the point, *K*, from which a horizontal dotted line cuts the British thermal unit scale at the right at 81.1; this corresponds with the amount obtained arithmetically in the foregoing calculation. In like manner ordinates are erected to the points *M* and *N* on the hydrogen and methane curves, giving the values 10.4 and 1.8, corresponding to similar values obtained by calculation. The sum of these factors or the total British thermal units per cubic foot of dry gas as obtained from the curves is

J. F. Mowat

J. F. Mowat, steam engineer of the Joliet, Ill., plant of the Illinois Steel Co., was born Nov. 8, 1882, at Peoria, Ill., and prepared for college at the local high school. He graduated from Cornell University in 1904, having received the degree of bachelor of arts and one and a half years later he completed the requirements for the degree of mechanical engineer. In 1906, Mr. Mowat entered the employ of the Illinois Steel Co. and after having served in various capacities in the engineering department, was appointed to the position which he now occupies.

shown in the lower left hand corner of Fig. 1. It is 93.3, checking closely with the figure 93.38, determined by calculation.

Fig. 2 contains a set of curves showing the properties of mixtures of air and saturated water vapor, at atmospheric pressure, for different temperatures. These apply equally well to any other perfect gases and, therefore, can be used for blast furnace gas. As these curves refer to a condition of saturation, we find that corresponding to the temperature of the dew point of the gas, 120 degrees Fahr., when the moisture is saturated, the volume occupied by the dry gas is 88.5 per cent of the volume of the mixture. This is indicated by the dotted horizontal line intersecting the curve on the temperature ordinate corresponding to 120 degrees, at point *P*, Fig. 2. By the laws of gases this percentage is not changed when the temperature of the mixture is reduced to 62 degrees Fahr. Consequently, if there is only 0.885 cubic foot of dry gas in a cubic foot of the mixture, the heat of combustion of the dry gas in the mixture is:

$$93.38 \times 0.885 = 82.64 \text{ B. T. U.}$$

The density must now be considered in order to determine the sensible heat of the dry gas between furnace temperature and 62 degrees Fahr. The various factors involved in the density are obtained from the group of curves, *C*, Fig. 1. Or the same result may be obtained analytically as follows: From a table giving specific weights of gases in pounds per cubic foot under standard conditions, the weight of each constituent in a cubic foot of the dry blast furnace gas can be found by multiplying the specific weight by the percentage shown on the analysis divided by 100. Thus,

		Pounds.
Nitrogen, ...	0.07382 × 0.570 =	0.0421
Hydrogen	0.00527 × 0.038 =	0.0002
Carbon dioxide, CO_2 ..	0.11562 × 0.140 =	0.0162
Carbon monoxide, CO.	0.07358 × 0.250 =	0.0184
Methane, CH_4 ..	0.04207 × 0.032 =	0.0001
Weight per cubic foot dry blast furnace gas under standard conditions....		0.0770

The same result as obtained from curves *C* is shown in the upper right hand corner, Fig. 1.

The variation in the specific heat of the ordinary run of dry blast furnace gas from 0.24 is so small that there is very little error in assuming it to be constant at this figure. The sensible heat of the dry gas in the mixture is the product of this specific heat, the weight of the gas and the range in temperature. Assuming the gas to enter the furnace at 400 degrees Fahr., the range in temperature above 62 degrees Fahr. is 338 degrees. As only 88.5 per cent of the mixture by volume is dry gas, the weight of the dry gas in a cubic foot of the mixture is 0.885 × 0.0770. Consequently, the sensible heat of the dry gas in a cubic foot of the mixture is $0.24 \times 338 \times 0.885 \times 0.077 = 5.52$ B. T. U.

In this case it was necessary to construct the nest of curves, *B*, Fig. 1, for different densities, as there were three variables to plot.

In the same way the sensible heat of the moisture above 120 degrees Fahr. is the product of the specific heat of steam, the weight in a cubic foot of the mixture and the range in temperature. The weight of a cubic foot of dry and saturated steam at 120 degrees Fahr., which is the weight of steam in a cubic foot of the mixture of gas and water vapor having a dew point of 120 degrees Fahr., is found, from the curve marked *saturated water vapor*, Fig. 3, to be 0.005 pound. Assuming the laws of gases to apply, the volume of 1 cubic foot of the mixture at 120 degrees Fahr., and 29.92 inch barometer, becomes at 62 degrees and the same pressure, 0.9 cubic foot. Then, the moisture in 1 cubic foot of the mixture at 62 degrees Fahr., and 29.92 inches barometer $= \frac{0.005}{0.900} = 0.00556$ pound.

Again assuming a constant specific

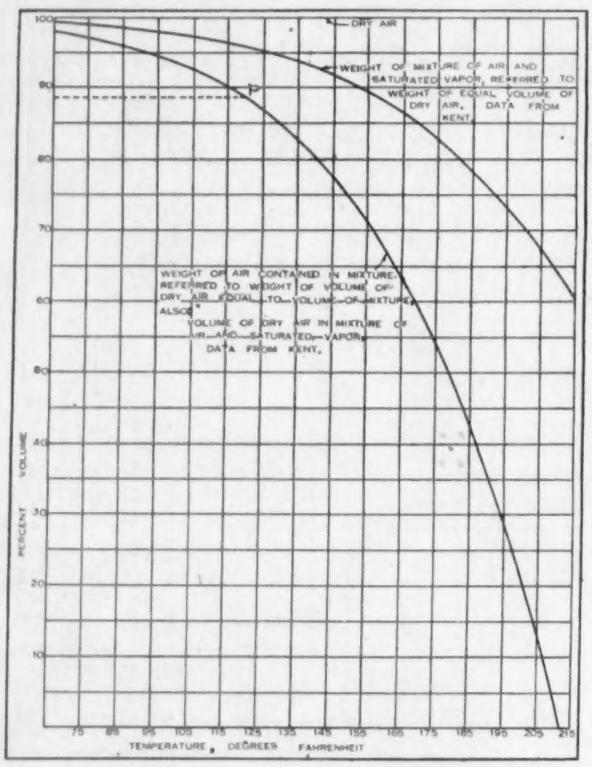

DRY AIR
WEIGHT OF MIXTURE OF AIR AND SATURATED VAPOR, REFERRED TO WEIGHT OF EQUAL VOLUME OF DRY AIR, DATA FROM KENT
WEIGHT OF AIR CONTAINED IN MIXTURE REFERRED TO WEIGHT OF VOLUME OF DRY AIR EQUAL TO VOLUME OF MIXTURE, ALSO VOLUME OF DRY AIR IN MIXTURE OF AIR AND SATURATED VAPOR, DATA FROM KENT.
PERCENT VOLUME
TEMPERATURE, DEGREES FAHRENHEIT

FIG. 2—CURVES SHOWING VOLUME OF DRY AIR IN MIXTURES OF AIR AND WATER VAPOR AT DIFFERENT TEMPERATURES

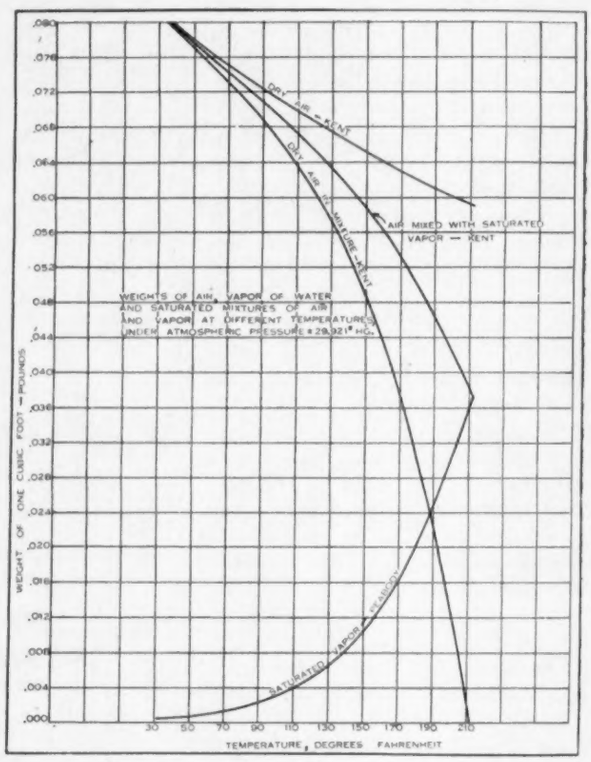

DRY AIR — KENT
AIR MIXED WITH SATURATED VAPOR — KENT
WEIGHTS OF AIR, VAPOR OF WATER AND SATURATED MIXTURES OF AIR AND VAPOR AT DIFFERENT TEMPERATURES UNDER ATMOSPHERIC PRESSURE = 29.921" HG.
SATURATED VAPOR — KENT
WEIGHT OF ONE CUBIC FOOT — POUNDS
TEMPERATURE, DEGREES FAHRENHEIT

FIG. 3—CURVES SHOWING WEIGHTS OF AIR, WATER VAPOR AND VARIOUS MIXTURES AT DIFFERENT TEMPERATURES

heat of steam of 0.48, which introduces a negligible error, we have the sensible heat of the moisture:

$0.00556 \times 0.48 \ (400-120) = 0.75$ B. T. U.

The same quantity may be obtained directly from curve *Z*, Fig. 1, as indicated by the dotted lines.

The three component parts of the available heat in the gas have now been determined, namely, the heat of combustion of the dry gas in the mixture under standard conditions; the sensible heat of the dry gas between the temperature of the entering mixture and 62 degrees Fahr., and the sensible heat of the moisture between the temperature of the entering mixture and the temperature of its dew point. The sum of the three factors is as follows:

B. T. U. of dry gas	82.64
Sensible heat of dry gas	5.52
Sensible heat of moisture	0.75
Total available heat per cubic foot of the mixture at 62 degrees Fahr. and 29.92 inches barometer, B. T. U.	88.91

The explanations given show how these rather cumbersome calculations may be avoided and time saved by the use of the curves. At the same time accuracy is maintained, for the curves give a total heat value of 88.78 British thermal units per cubic foot, as shown at *H*, Fig. 1. The error, compared with the value, 88.91 obtained by calculation, is only 0.15 per cent.

Testing Case-Hardened Steel

In a paper on measurements and relations of hardness and depth of carbonization in case-hardened steel, presented at the Cleveland meeting of the American Institute of Mining Engineers, Mark A. Ammon, of Cleveland, discussed the results of an investigation into the hardness of case-hardened steel. He states that the two most widely used methods of measuring hardness are the Brinell and scleroscope. In the Brinell method, a hardened steel ball is pressed into the steel under a definite load and the area of the resulting depression is measured. Within certain limits, the hardness number is independent of the load or the size of the ball. In the scleroscope method, a small weight carrying a diamond point is dropped through a glass tube upon the steel and the amount of rebound is taken as proportional to the hardness. While in both methods the scale of hardness is an arbitrary one, they agree in a comparative way, that is, a steel showing 50 per cent harder Brinell will show approximately 50 per cent harder scleroscope, and it appears that this should not be the case with a carbonized steel. The scleroscope method gives almost exclusively the surface hardness, and the condition of the material below the surface has only a slight bearing on the hardness number. The results by the Brinell methods should be exactly opposite, for the depth of penetration of a ball pressed into the steel would be largely dependent upon the condition of the material below the surface. In the investigation, a combination of these two methods was used in the hopes of developing a process whereby the depth of carbonization could be determined with a reasonable degree of commercial accuracy.

Investigations on Two Steels

Duplicate investigations were made upon two different steels. One of these steels, known as No. 2, analyzed as follows: Carbon, 0.233 per cent; phosphorus, 0.011; sulphur, 0.019; manganese, 0.53 per cent. The other specimen, No. 8, analyzed: Carbon, 0.188 per cent; phosphorus, 0.008; sulphur, 0.020; manganese, 0.53, and nickel, 3.30 per cent. Each of these steels was carbonized at two different temperatures, 1,650 degrees and 1,750 degrees Fahr. At successive periods, one piece of each grade was taken from the furnace and quenched in water, while two others were permitted to cool in the carbonizing box. The latter two were then reheated and quenched, one receiving a double and a single quench. The piece quenched from the box originally, received afterward a second low heat. The test pieces were steel disks, 1 inch thick, the two flat surfaces being ground smooth. The diameter of the disks was 1⅞ inches for grade No. 8 and 2 inches for No. 2. Three of each kind were packed in a cast iron pot, 8 inches diameter and 12 inches high, making six disks in each pot. The time was divided into 10 periods and 10 pots, each containing six disks, were placed in a large furnace giving a uniform temperature of about 1,650 degrees Fahr. The temperature in the second furnace, similarly loaded, was maintained at 1,750 degrees Fahr. After each operation, the disks were carefully smoothed with fine emery cloth and three Brinell and 10 scleroscope readings were taken on each disk and averaged. One disk of each grade was taken from each box after cooling and a small piece was sawed out of the edge, polished, etched and the depth of carbonization measured under the microscope. Allowing for a few discrepancies, results showed consistent uniformity in demonstrating certain facts. Under like conditions, the carbonization rate of penetration in the carbon steel was 1.07 times the rate in the nickel steel at the low temperature. At the high temperature, this rate for the carbon was 1.15 times that for nickel. The average rate of penetration of the carbon steel at the high temperature was 1.48 times the rate at the low temperature, while for the nickel steel, the figure was 1.41, showing the great influence of temperature.

Regarding the hardness after carbonizing and before quenching, the most apparent fact noted is a higher scleroscope reading after carbonizing, compared with the reading before carbonizing, while the corresponding Brinell readings are only slightly higher in grade No. 8 and even lower in grade No. 2. This is explained as follows: The scleroscope method measures the increased hardness due to higher carbon. The Brinell hardness, being more a function of the core than of the surface, is actually made less for the lower depths of carbon, due to the soft annealing produced by the slow cooling in the carbonizing boxes. As the depth of carbon increases, this Brinell reading is more and more influenced by it and less by the conditions of the core.

Decrease in Hardness

After quenching from the carbonizing box, the scleroscope readings show a gradual decrease in hardness with increased depth in carbon after the first hour of carbonization. The Brinell hardnesses, corresponding to the scleroscope hardnesses, show some slight irregularities, undoubtedly due to differences in the cooling rate caused by mechanical difficulties of quenching from large carbonizing boxes. As shown by the scleroscope, the hardness after the first quenching on the double-quenched specimens, is considerably higher than that obtained from the quenching direct from the box. In the Brinell hardness, after the second quenching, a remarkable dropping off in hardness is noted. The author states that knowledge gained by the research has formed the basis of a system of testing carbonized parts for depth of carbonization and efficiency of the heat treatment.

The first recorded suggestion of the use of gas for fuel was in a patent taken out in England, 1805, by F. A. Winsor, for a process of extracting inflammable air from coal, and the product was to be applied to heating as well as to lighting.

A view of the Livingstone Channel, looking south. This tremendous undertaking

A New Route for Downbound Vessels Which

THE commerce of the great lakes is one of the wonders of the world, and congress displays the highest wisdom in appropriating liberally for the improvement of its channels, because the aim and end of improvement is reduction of transportation costs. Figures have been compiled which prove that the total cost to the United States of river and harbor improvements on the great lakes from their inception is less than the present direct annual saving in cost of transportation resulting from such improvements. This is a dividend in which all of the people share. It is idle to think that the vessel owner or those directly associated with lake trade get the benefit of the improvements. The saving affects the cost of living generally, for lake trade is the life blood of many industries, and its influence is disseminated in more or less degree over the whole United States.

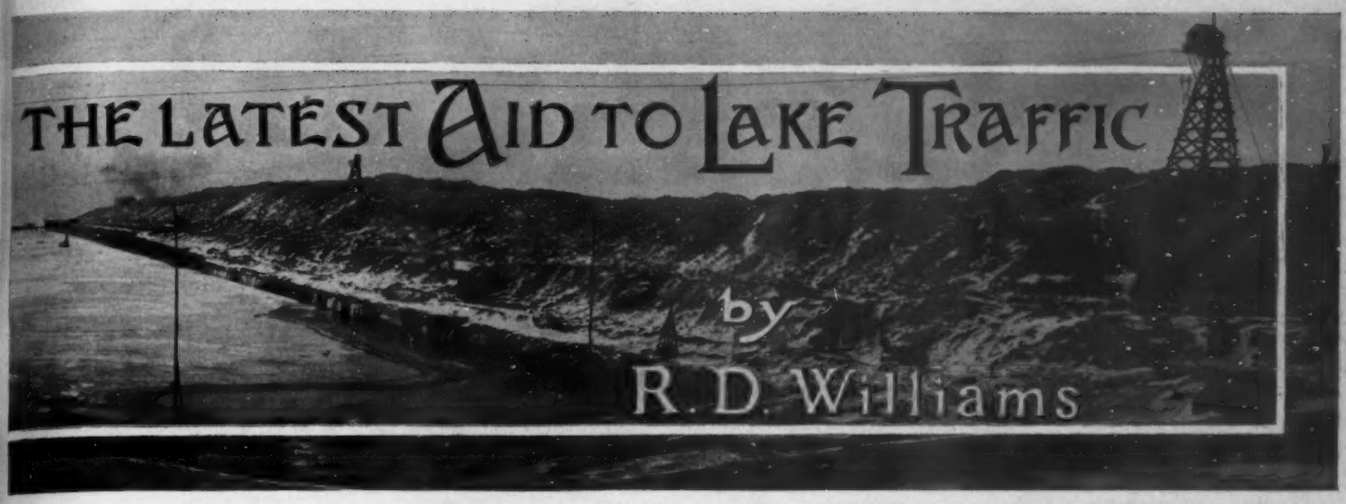
Tonnage Through Detroit River

During 1912 over 80,000,000 tons of freight passed either up or down the Detroit river. Until Oct. 19, 1912, every pound of this commerce passed through a channel only 600 feet wide and beset with numerous cross currents and jagged sides and bottom of rock, known as the Limekiln Crossing.

It is characteristic of lake trade that the improvement of channels and harbor facilities has not kept pace with the growth of commerce. The dangerous character of the Limekiln Crossing was not especially noticeable when the trade was handled in ships of smaller tonnage, but the growth in the size of ships was very rapid and the need of a safer waterway at this point was long felt before the work was undertaken.

In 1906, when the 600-foot ship had actually made its appearance on the lakes, surveys were made to determine the route for a channel at the mouth of the Detroit river which would evade the Limekiln Crossing. Three routes were selected for examination, but the one finally determined upon was a channel leaving the old channel about 1 mile north of Limekiln Crossing and proceeding in a straight line to the Detroit river lighthouse at the mouth of the river, passing east of Stony Island and west

EXCAVATING IN THE DRY IN THE LIVINGSTONE CHANNEL, SHOWING THE



can, in part, be measured by the large amount of excavated material at the right.

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Will Greatly Facilitate Great Lakes Shipping

of Bois Blanc island. In 1907, congress appropriated funds for this improvement and authorized it to be known as the Livingstone channel in recognition of the many services rendered in the interest of navigation by William Livingstone, president of the Lake Carriers' Association.

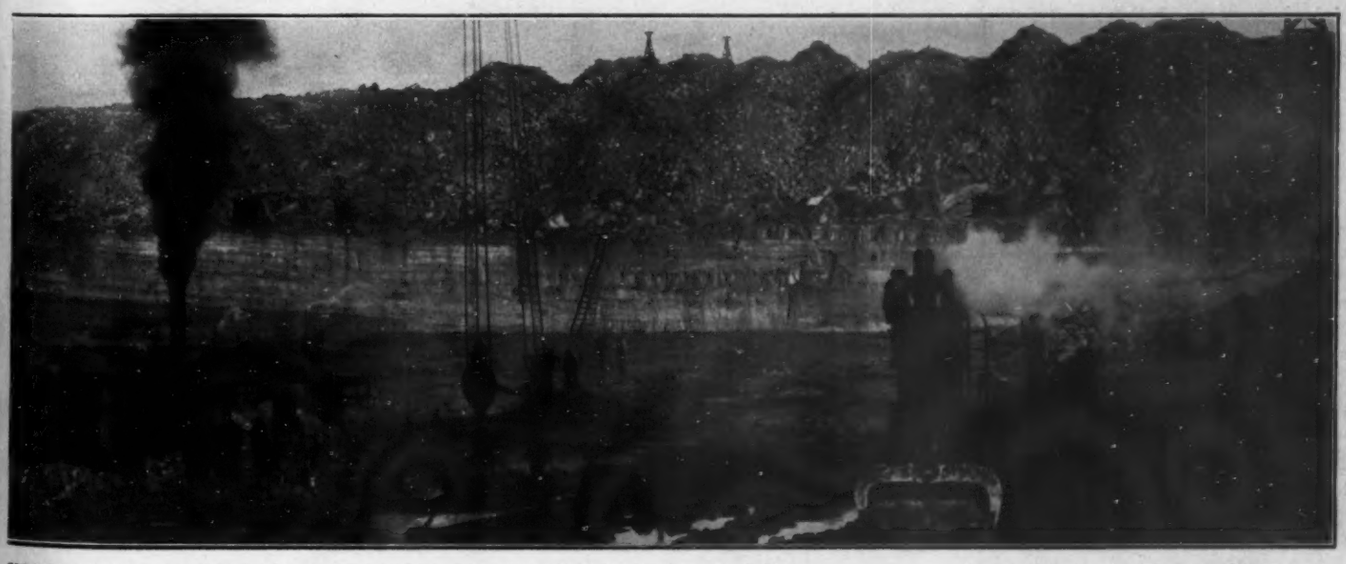
This project provided for a depth of 22 feet at a low water stage and for a channel width of 300 feet for the north 6 miles and thence for an 800-foot width for 6 miles further to deep water in Lake Erie. The work was divided into four sections, determined mainly on the character of material to be excavated and the contour of the bottom.

The first section, being most northerly, was 5,800 feet long and 300 feet wide and the material was mainly limestone bed rock of an average depth of about 4 feet above the required grade. The amount of money involved in this portion of the contract was about $676,000.

Excavated in the Dry

The second section was 7,500 feet long and 300 feet wide, the material being limestone bed rock overlaid with earth at the south end for a distance of about 3,500 feet. The contract required that at least 4,000 feet length of this area near its north end should be enclosed by dams, the enclosed area unwatered and the excavation made in the dry. The river at this point is quite shallow, ranging in depth from 2 to 10 feet, the average depth being probably about 4 feet, and it was considered simpler and cheaper to cofferdam the river at this point and excavate as though the work was being prosecuted on dry land. The original intention was to cofferdam only the 4,000 feet required in the contract, but after the work was well under way the contractors extended their dams 300 feet to the northward of the 4,000 feet stipulated in the contract and 1,500 feet to the southward, making the entire area finally cofferdammed 5,800 feet long with an average width of about 1,200 feet, or altogether 160 acres.

For excavating in the dry the contractors received $1.24 per cubic yard for rock and 60 cents for earth. For excavating in the wet the contractors received $3.40 per cubic yard for rock and 60 cents for earth, so that there



SMOOTH WALL PRODUCED AT THE SIDES BY THE CHANNELING MACHINE

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was a material saving to the government in working in the dry. A payment of $25,000 was made for cofferdam construction after the enclosed area had been unwatered and kept dry for one month. The depth of rock cutting within the cofferdam varied from 10 to 19 feet and for the south 4,000-foot length the average depth of rock cutting was about 17 feet. The side walls were required to be channeled, and have the appearance of stone masonry. The total amount of money involved in this part of the contract was about $1,800,000, the estimated saving over dredging in the wet being about $700,000.

The third section embraced an area 18,250 feet long and 300 feet wide, except for the south 1,000 feet, where the width increases from 300 to 500 feet. The material was limestone bed rock with earth and boulders overlying and the price paid for this work was $2.80 per cubic yard for rock and 50 cents for earth, the total amount of money involved being about $2,834,000. This price may on the face of things appear high and would be were it not for the fact that a considerable part of the area was exposed to heavy seas, rendering rock drilling and blasting difficult and expensive, and sometimes impossible.

The fourth section embraced an area 29,000 feet long and 800 feet wide except for the north 1,000 feet, where the width decreased from 800 to 550 feet. The material was clay, sand, gravel, silt and some hardpan. The price paid for this work was 25½ cents per cubic yard. This entire area was exposed to heavy seas and the amount of money involved in the contract was about $950,000. The total cost of the work was $6,270,000.

Features of dry Excavating

There were many special and interesting features in connection with the work of excavating in the dry. The locality was well-adapted to this form of excavation owing to the fact that the extremely shallow water rendered the cost of the dam small in comparison to the amount of material to be excavated. On the other hand, the bids were predicated on the assumption that the dam could be constructed of the excavated materials which might, after all, prove unsuitable. Moreover, there was the danger of finding underground seams in the rock and there was always present the possibility that an unusually high stage of water might flood the area after it had been unwatered, so that other contractors were in quite common agreement that the successful bidders were taking desperate chances. Should any of these contingencies have developed it would have meant a losing contract, but Grant Smith & Co., and Locher, the successful bidders, had recently completed a similar work at West Neebish, in the St. Marys river, and were prepared for all emergencies.

The material for the dams consisted mainly of clay and boulders which were excavated from the channel outside of the area to be enclosed, for which excavation payment was made at the contract rate. This material was loaded on flat scows, towed to the site of the dams and unloaded by steam scrapers. Later a small dredge was used to cast over some of the material on top of the dams. When building the north dams a core of broken rock was first built to the water surface to break the force of the current, then other material was dumped over the rock to make the dam tight. Elsewhere only clay and small boulders were used. The dams proved unusually tight, very few leaks developing.

CHANNELING MACHINE AND STEAM SHOVEL, LIVINGSTONE CHANNEL

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The entire plant was operated by compressed air except the steam shovels and some of the pumps. The compressed air plant consisted of two compressors, one of 700 and one of 300 horsepower. When only part of the plant was at work but one

compressor was used, thus making it possible to keep one engine in thorough repair constantly.

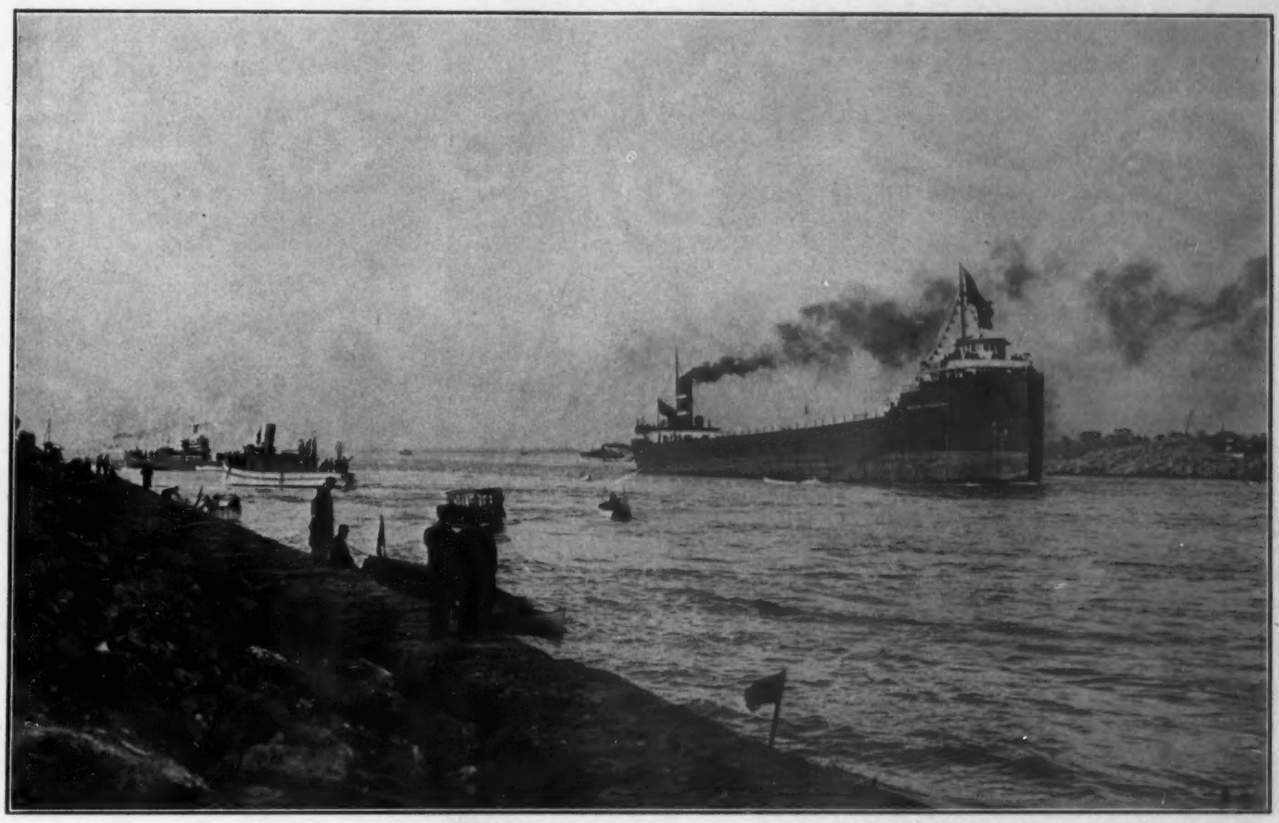
Prior to the rock being disturbed by drilling and blasting, the sides of the channel were cut from the rock and made smooth and vertical by the use of channeling machines. For a length of about 2,500 feet where the depth of cutting was greatest, the rock was taken out in two lifts of from 9 to 10 feet. At this locality the offset in the channel wall was about 9 inches, the distance between the walls being the required 300 feet. The machines were caused to travel forward and backward on tracks for a distance of about 10 feet, continually chopping the rock until the entire depth of cutting was made, then the track was moved forward. There were three channeling machines in use, each of which was operated by three men. The average rate at which the channeling was done was about 12 square feet per machine per hour.

The drilling plant originally consisted of a number of small, portable, tripod drills, the number in use varying from 10 to 16. After the contract was well under way a new type of drill designed by C. H. Locher and known as the traction drill, was used with extremely good results. The holes were usually drilled at the corners of from 6 to 8-foot squares. For the tripod drills it was necessary to change the bits for every 2 feet of depth, starting with a 2½-inch hole and making the hole smaller by ⅛ inch with every change of bit. The traction drill was designed to make a 5-inch hole of 16-foot depth without changing bit. With the small tripod drill the holes were made at an average rate of about 5.8 feet per drill per hour, and with the traction drill the average rate was about 18.5 feet per hour, or more than three times the rate of the small drill. The traction drill was designed to clear the hole more thoroughly from chips, making the blow more effective. This was accomplished by a valve within the drill pipe through which the chips were forced with water at each blow. Each drill was operated by two men. By the substitution of this drill Mr. Locher succeeded in making two men do six men's work.

Blasting

After the holes were drilled they were loaded with dynamite and fired, the blasting being done usually at meal hours when all other workmen were at a safe distance. Usually two rows of holes were fired at a time and these only for half of the channel width. The dynamite used was of the 60 per cent and 40 per cent grades, the latter being used near the side walls and near the top of deep holes. The amount of dynamite used averaged 1.5 pounds per linear foot of hole and 0.8 pound per cubic yard of material excavated. Extreme care was used in selecting men for this class of work and on the whole contract no accident of any kind resulted from the use of dynamite.

Three traction steam shovels were used and the area was divided into three nearly equal parts, one for each shovel. The operators of the shovels became very skillful in handling their machines and many large pieces of rock were removed quickly and without damage. All material was loaded into skips of about 3 cubic yards capacity. Following the steam shovels a gang of laborers cleared the bottom of all loose rock, loading it into the skips by hand labor. The loaded skips from the steam shovel and labor gang were carried to the spoil bank by the cableway and were dumped. After the removal of all broken rock the elevations of the highest points of the bottom were obtained by the use of a surveyor's level as a means of determining that



THE BULK FREIGHTER WM. LIVINGSTONE OPENING THE LIVINGSTONE CHANNEL IN THE LOWER DETROIT RIVER, OCT. 19, 1912

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the required depth had been secured. Where necessary, the high points were reduced by drilling and blasting and by hired labor. Thus, as the work advanced, it was left completed. The average daily rate of removing material per steam shovel per day of eight hours was 424 cubic yards.

The Use of Cableways

Three cableways were used, one with each of the steam shovels, to carry the excavated materials to the spoil bank. These cableways were of 726 feet span and they were supported by two towers about 100 feet high. Each set of cableways consisted of five cables; one to support the entire load, one to hoist, one to haul, one to dump and one to support and distribute carriers to prevent entanglement of cables. The engine for operating the cableway was housed at the base of one of the towers. All signals to the engineer were communicated by the use of electric bells operated by a bell boy stationed where he could watch the work and receive the signals from the foreman. The process of dumping the loaded skip was as follows: The hoisting cable was lowered to the skip and when attached, the load was raised to the required height, then hauled to the spoil bank, where it was dumped by the engineer throwing the dump line upon a larger drum causing it to travel faster than the hauling line and thus dump the skip. The empty skip then was returned to the steam shovel on the reverse process. The signal for each of these operations was communicated by the engineer to the bell boy. This method of aerial dumping was designed by C. H. Locher and greatly reduced the cost of disposing of material by cableways. As the excavation progressed the towers were moved forward on tracks and kept abreast of the work.

Pumping Plant

The main pumping plant consisted of one 18-inch and two 12-inch pumps, all operated by steam. There were several smaller pumps, usually operated by compressed air, which were moved from place to place as they were needed. Except after heavy rains, a portion of the pumping plant was usually idle for a part of every day. The area first unwatered was 2,800 feet long with an average width of about 1,500 feet. Within this area the average depth of water was about 6 feet, the quantity of water being nearly 200,000,000 gallons, and the area was unwatered in 25 days.

The whole work was completed last October and the bulk freighter William Livingstone, under the pilotage of President Livingstone, of the Lake Carriers' Association, was selected to open the channel to navigation on Oct. 19. The first vessel to actually carry a cargo through the channel was the bulk freighter William E. Corey, which immediately followed the Livingstone through.

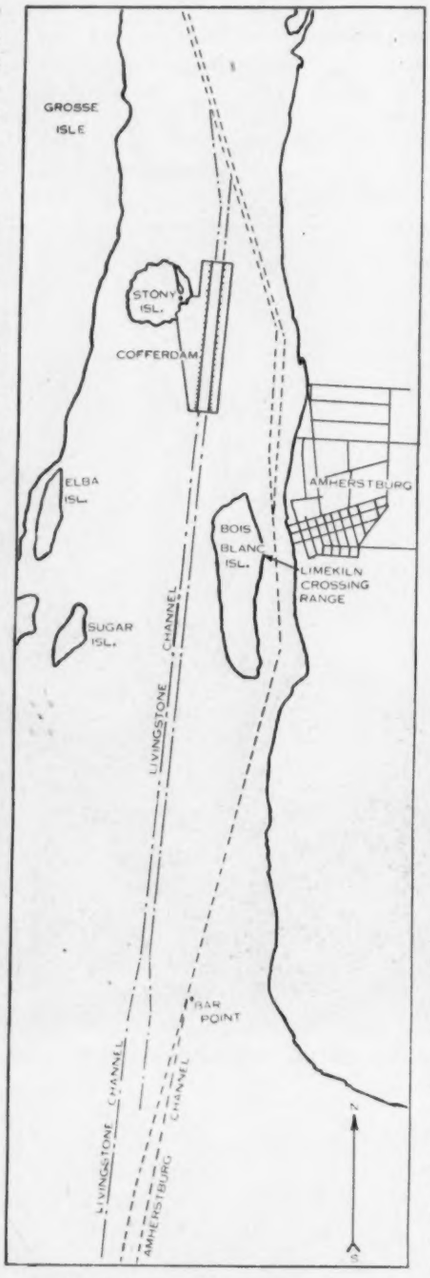


DIAGRAM OF THE LIVINGSTONE CHANNEL

It is intended that this new channel shall be used exclusively for down-bound traffic and if by reason of this improvement the saving in transportation cost is only 1 cent per ton, the channel will have paid for itself in eight years.

Vanadium in Pig Iron

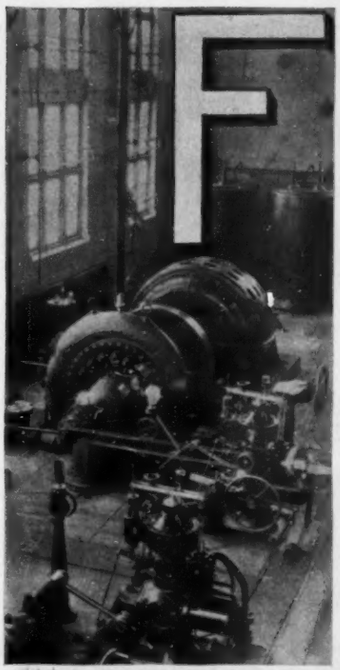
In a paper on "Vanadium in Pig Iron," delivered before the American Institute of Mining Engineers, Porter W. Shimer, Easton, Pa., stated that it does not seem to be generally known that some American pig irons contain notable amounts of vanadium, and that it is hoped that a recent investigation will call attention to the importance of looking for this element. The majority of the pig irons investigated were made in the Lehigh valley and neighboring furnaces, using more or less New Jersey magnetite in their mixtures. Probably all of these ores contain a small amount of vanadium as well as titanium, the ore from one of the largest of these mines containing 0.05 per cent vanadium and 0.60 per cent titanium. Dr. Thomas M. Brown was the first, according to the author, to detect vanadium in the incrustations occurring on certain pig irons, and he also found this element in a number of magnetites. In a general way, the Lehigh valley pig irons contain from 0.02 to 0.05 per cent of vanadium and from 0.10 to 0.20 per cent of titanium. These elements follow the silicon, that is, the furnace conditions which produce a high silicon, low sulphur iron will cause the maximum reduction of vanadium and titanium, and iron with low silicon and high sulphur will have a lower content of these elements.

That not all pig irons made wholly of magnetic ores contain these amounts of vanadium is shown by the fact that two widely separated furnaces, using all magnetite, none of which is from New Jersey, were found to contain respectively 0.006 and 0.012 per cent of vanadium. An iron made wholly of Virginia hematite ore contained 0.014 per cent of vanadium, and two irons, presumably made wholly from Lake Superior ores, contained respectively 0.009 and 0.023 per cent. Vanadium sometimes occurs in limestone and in the ash of coke, and no doubt these contribute vanadium to the iron. Mr. Shimer stated that there is reason to believe that the effect of vanadium on the strength and other qualities of these irons is noticeably beneficial, and that titanium acts in a similar way. As to the addition of vanadium to pig iron to increase its strength and to refine its grain, the author says that it is probably safe to assume that greater improvement may be looked for when it is added to weak irons which do not already contain notable amounts of this element.

Application of Electric Power to Mining Work

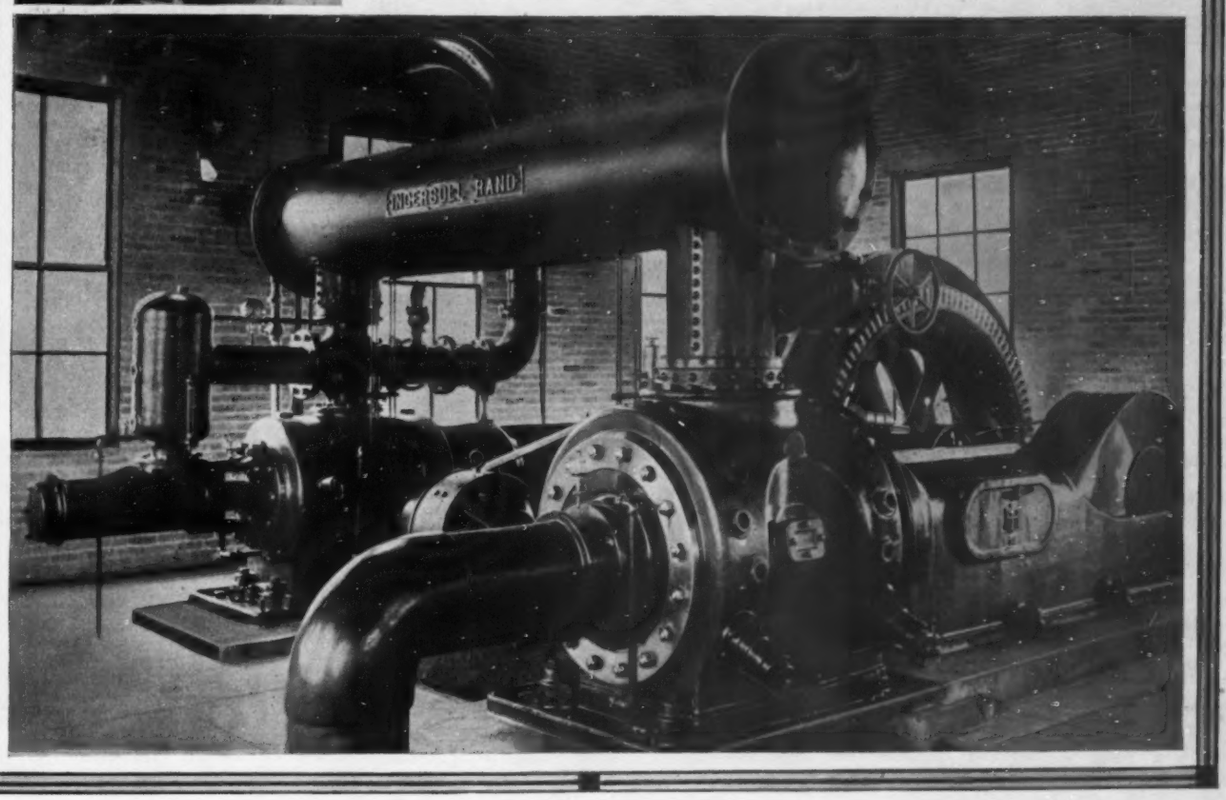
Recent Developments in the Use of High Speed Air Compressors and Synchronous Motors on the Lake Superior Ranges

By C A Tupper



FOR several years repeated attempts have been made in iron mining districts to introduce the use of electric power on an extensive scale for the operation both of surface machinery and underground equipment, beginning usually with the pumps, compressors and hoists. The progress made, however, has not been what might be expected, compared with the success of electric drive in other industrial fields. This is due mainly to the peculiar problems involved, which vary radically for each class of equipment. At first, the attempt was invariably made to take existing types of equipment, including both the driven machines and the motors, and couple up the two for operation — whether directly, with gearing, or through belting—without much regard to the particular characteristics of either. The results were, in most cases, very unsatisfactory and delayed for a considerable period the actual electrification of many important properties. Gradually, it became apparent to manufacturers and users of mining machinery, the same as it had earlier upon operators in the metal-working field, that what was needed was the practical re-designing of both driven machines and motors, and to a considerable extent the introduction of much higher speeds, to meet the exact conditions of mining service.

Among the various problems presented, that of electrically-operated compressors has been prominent, and, during a recent trip over the northern iron ranges, the writer was greatly interested to observe the progress made there within the past year. One of the pioneers in bringing about the new order of things is the Cleveland-Cliffs Iron Co., whose operations on the Marquette range have already

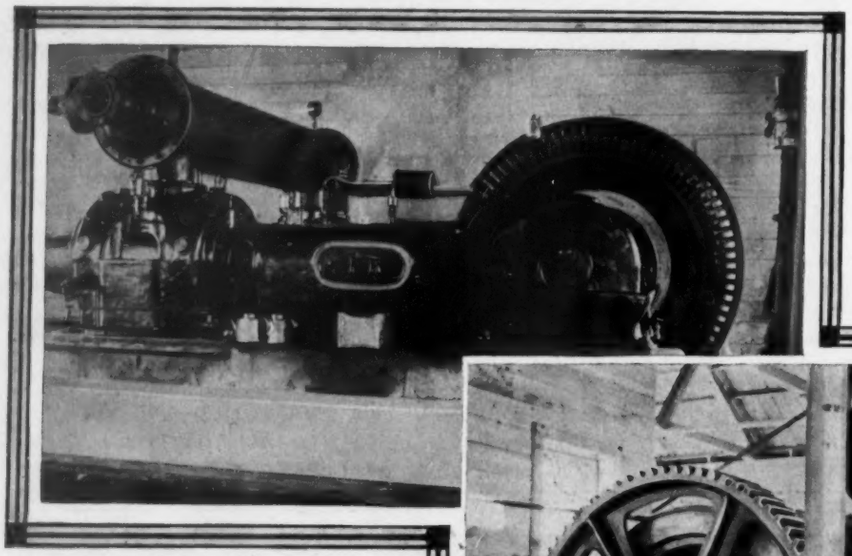


CARP RIVER PLANT, CLEVELAND-CLIFFS IRON CO., SUPPLYING CURRENT TO MOTOR-DRIVEN AIR COMPRESSORS

MOTOR DRIVEN AIR COMPRESSOR INSTALLATION AT THE DAVIDSON MINE

been quite fully described in THE IRON TRADE REVIEW, but examples of equal interest are to be found in the Iron river district of the Menominee range, where several motor-driven compressors of the larger capacities recently were placed in service. The first of these plants visited by the writer were those of the Wickwire Mining Co., at the Wickwire and Cortland mines, Iron Range, Mich., the details of which are decidedly instructive.

The compressor installed at the Wickwire mine is an Ingersoll-Rand P. E. 2, 2-stage machine, having air cylinders 18¼ inches in diameter by



CORTLAND MINE COMPRESSOR

16-inch stroke. At 225 revolutions per minute it delivers 995 cubic feet of free air per minute, the receiver pressure being 100 pounds. The writer was chiefly interested, at the start, in considering this unit from the standpoint of compressor design and will, therefore, take up the various basic features of construction before entering upon the auxiliary details which form part of the operation of the plant as a whole.

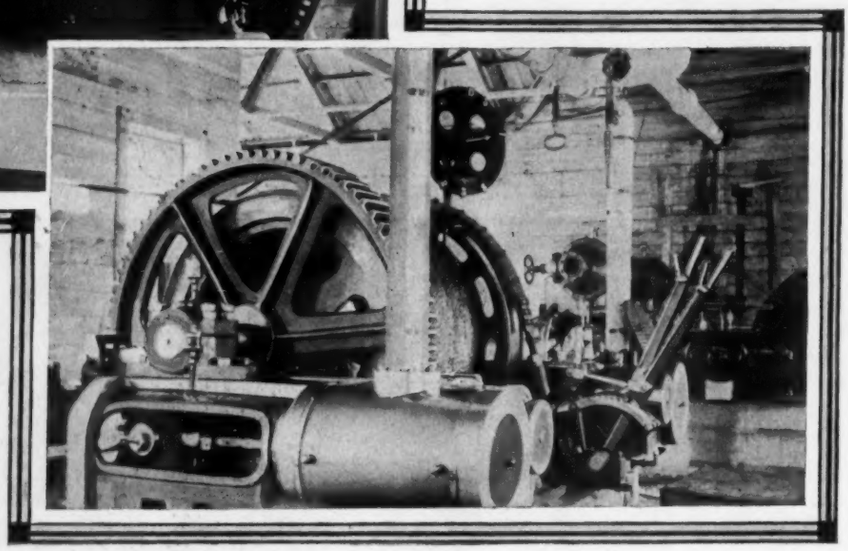
The first feature to attract attention in a high speed compressor of this type, even from superficial observation, is that the frame on each is of the unit, heavy-duty engine design, supported for its entire length on the foundation, while the cylinders, resting on sole plates, are made with a full box underneath instead of a foot. The whole of this box is a part of the water jacket and serves as a settling chamber. Next, it is noted that the compressor is accessible, both inside and outside. At the driving end are the main bearings, of the three-part pattern, in which a film of oil is constantly maintained between the shaft and the babbitted shells. On the sides are the cranks, cross-heads and connecting rods. These are accessible, while the machine is in operation, through the front and top doors on the oil guards and through a large door on the side of the main frame. The air pistons can be withdrawn at the back. In these and other respects, first class engine construction has evidently been followed.

The air cylinders, cooling system and method of lubrication have also a story of interest for the close observer. At each inlet port there is a piston carrying two ring valves, one on each face. Each valve is a ring of solid forged steel turned to a light T-section. Bolted to the face of the piston is a steel guide plate, with a series of large openings, close to its circumference. The ring valve rests loosely between the guide plate and the piston face, the bar of the T forming the valve face and the upright of the T the guide section sliding on the guide plate. The travel between guide and piston is the lift of the valve. The construction is identical on both faces of the piston. The two valves travel with the piston, the one in front closing by its inertia, and remaining closed under the air pressure in advance of the piston. The other valve, assuming that this is the first stroke, drops back against its guide plate the moment the piston starts, making a full valve opening which is maintained until the piston stops, when this valve, continuing its motion, slides easily to its seat.

On the return stroke the leading valve, which was the following valve on the forward stroke, is already closed and compression begins at once. The following valve is now held to its seat by clearance pressure until enough of the stroke has been completed to expand the clearance air to intake pressure. This valve then drops behind the piston because of its inertia, thus fully opening and remaining open until the end of the stroke, when it closes instantly. That completes the cycle for one revolution, and this cycle is repeated so long as the machine is running.

The discharge valves are of the cushioned, direct-lift type, designed with the object of affording the maximum discharge efficiency and the maximum discharge area, with a comparatively small lift. These valves are arranged radially in the cylinder and seat directly on the metal of the barrel, thus not only rendering any removable valve seats unnecessary, but also leaving the entire head free to be completely water-jacketed. This is particularly important, as the air in the cylinder is in contact with the head throughout the stroke.

The system of lubrication is particularly effective. It provides for delivering a constant stream of oil to the main bearings, crank pins and



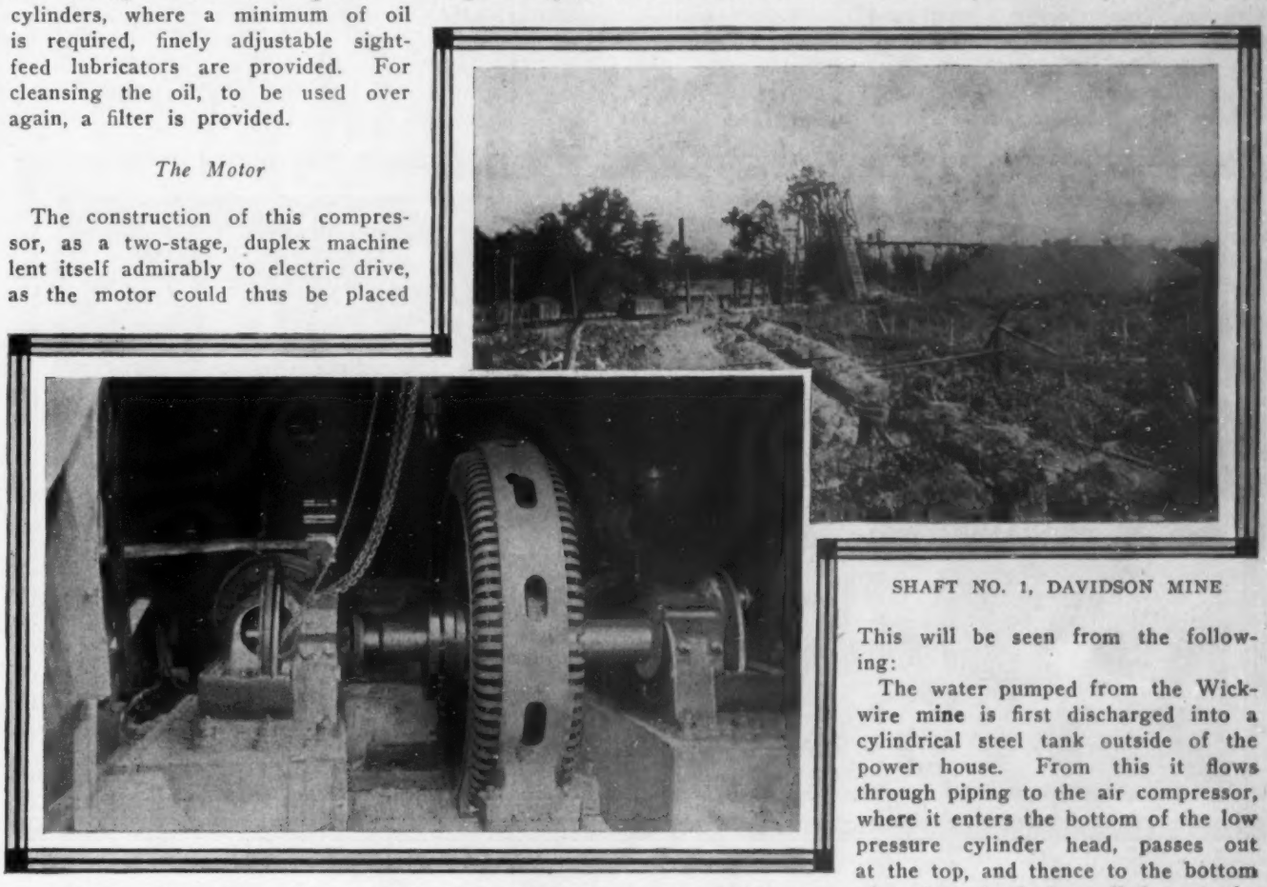
CORTLAND MINE HOIST OPERATED ON AIR FROM MOTOR-DRIVEN COMPRESSOR

crosshead pins. In the main frame is an oil reservoir into which the crank discs dip. A small quantity of oil is continually being carried up on the edges of the discs and is caught at the top in wipers which drain into small pans. Piping leads from these pans to the parts above mentioned as well as the crosshead guides and piston rods. The flow of oil begins as the machine starts and its delivery is, of course, automatically proportioned to the speed of the compressor. Oil flowing through the bearings returns to the crank basin to be used over again until drained for filtering. For lubricating the air cylinders, where a minimum of oil is required, finely adjustable sight-feed lubricators are provided. For cleansing the oil, to be used over again, a filter is provided.

The Motor

The construction of this compressor, as a two-stage, duplex machine lent itself admirably to electric drive, as the motor could thus be placed between the bearings with the rotor securely pressed and keyed on the main shaft. This machine is a Westinghouse synchronous motor of 170-horsepower capacity, operating on three-phase, 60-cycle, alternating current at 2,200 volts. It is constructed along the lines of engine type generator design, thus giving an efficiency greater than that of a high-speed belted motor. The idea has evidently been adhered to of producing a unit of which the compressor and motor comprise closely related parts; hence, the large pillow block construction of the main bearings, ample bearing surfaces and rigid shaft. On account of the small clearance between the motor stator and rotor, the shaft has obviously been made sufficiently rigid to guard against any deflection, and the motor yoke is supported by cast iron cap plates set in the foundation, means for adjusting the motor alignment being provided at this point and in the main bearings.

The rotor of the motor is also heavy enough to give a flywheel balancing effect, and advantage has been taken of the fact that an exciter is required with a synchronous motor, to add to this effect, by driving the latter from a belt wheel sufficiently large to impart the steadiness needed.



MOTOR BEING INSTALLED TO DRIVE CORTLAND MINE COMPRESSOR

A speed of 225 revolutions per minute is high for a compressor of this size, but it is made entirely practicable by the liberal design and flood system of lubrication. Hence, as the capacity of the unit increases directly with the speed, and its mechanical efficiency likewise, such speed has material advantages. A Chicago Pneumatic Tool Co. steam-driven compressor, used in the early development work, is held in reserve.

The Wickwire mine appears to be partially drained through other properties in the vicinity. It makes about 200 gallons of water per minute. This quantity was originally handled by a No. 8 Cameron pump of 150 gallons rated capacity; but to provide for the increased volume of water which will result from the further opening of the mine, the management installed a Buffalo Steam Pump Co.'s two-stage, 3-inch centrifugal unit of 300 gallons delivery per minute, against a 119-foot head. This is driven by a 35-horsepower, 1,200 revolutions per minute, General Electric synchronous motor. A similar unit is in use at the Cortland mine.

The above paragraph would appear to be a digression from the subject of compressor service; but, as a matter of fact, it is closely related to it.

SHAFT NO. 1, DAVIDSON MINE

This will be seen from the following:

The water pumped from the Wickwire mine is first discharged into a cylindrical steel tank outside of the power house. From this it flows through piping to the air compressor, where it enters the bottom of the low pressure cylinder head, passes out at the top, and thence to the bottom of each end of the cylinder, at the top of the water space, which issues in an open funnel connected with a drain in the sole plate. Consequently, the flow of water is always visible and can be regulated properly. From the low pressure side of the compressor its circulation continues on through the intercooler.

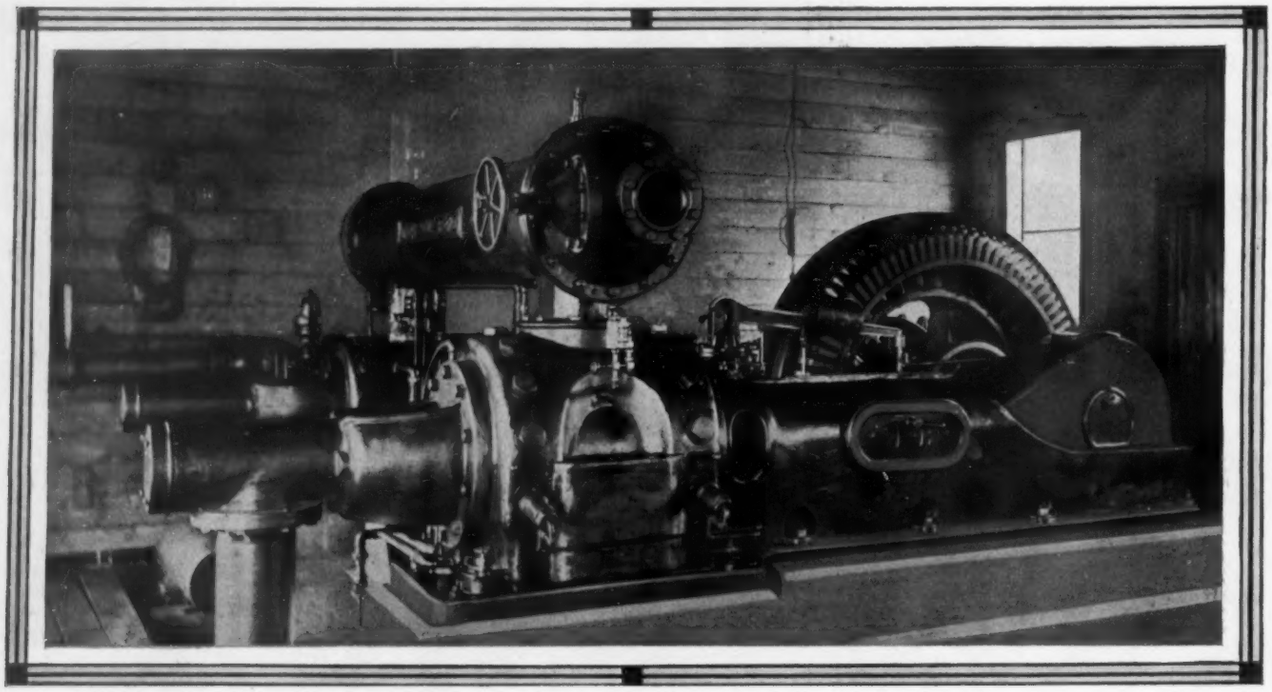
The intercooler is set transversely above the air cylinders. This is made with a double set of galvanized iron tubes, the outer or larger of these, with which the air comes in contact, being screwed into the tube plate at one end and having the outer ends closed with caps. The inner or water tubes are set inside of the air tubes, being free at one

end and screwed into the water head at the opposite end, with both ends open. The water head in its outer section is cast with cross baffles, and is made with intermediate baffles at its inner face, the lower baffles meeting the tube head. Cooling water enters the lower row of tubes in the cooler, and passes successively backward and forward between the inner and outer tubes, finally discharging from the top row. Leaving the intercooler, the water passes around and beneath the high pressure cylinder, and thence to the jacket of the head from below. Discharge is through the side of the cylinder. Under the compressor is a small steel tank into which the condensed moisture from both intercooler and separator is drained.

From the condenser jackets and intercooler, the stream of cooling water flows to a wooden tank adjacent to the boiler house and is forced by an injector into the boilers. Circulation is maintained by a small steam pump, which can be used also directly as a boiler feed pump by by-passing the compressor.

The electric power used in the Wickwire and Cortland mines is purchased from the Peninsular Power Co. at the very low rate of 1 cent per kilowatt-hour, or higher if 60 per cent load factor is not maintained, a point which will be elaborated upon farther along in this article. Current comes in at 6,600 volts, and is stepped down to 2,200 volts at the Wickwire mine, by three Westinghouse 125-kilovolt-ampere, oil-cooled transformers, at the same time being measured by a Thompson high torque wattmeter. The incoming lines are equipped with a Westinghouse lightning arrester, and are controlled from a panel fitted with Westinghouse apparatus. There is a Westinghouse switchboard for the 170-horsepower motor driving the compressor and its 6-kilowatt exciter.

At the Cortland mine the compressor is also an Ingersoll-Rand machine, driven by a Westinghouse motor of the same design as the above, but larger, being 12½ and 21¼ x 18 inches. It supplies 1,352 cubic feet of free air per minute at 200 revolutions per minute. The motor is rated at 200 horsepower with a 5-kilowatt exciter. The hoist is run by compressed air. The arrangement of the incoming electric line is similar to that described. There are three, 125-kilovolt-ampere Westinghouse 2,200-220-volt transformers, lightning arrester and the necessary switchboard panels.



WICKWIRE MINE, MOTOR-DRIVEN AIR COMPRESSOR PLANT

Regulation of the Compressors

Regulation of the compressors at the Wickwire and Cortland mines is effected in five stages—full load, three-quarter load, one-half load, one-quarter load and no load—by means of an automatic clearance controller. This consists of a number of clearance pockets which are thrown automatically into communication with the ends of each air cylinder in proper succession, according to a predetermined variation in receiver pressure.

The operation of the system is as follows:

With the compressor operating at partial capacity, a portion of the air is compressed into added clearance space instead of passing through the discharge valves. On the return stroke this air expands, giving up its stored energy to the pistons. The inlet valves remain closed until the cylinder pressure equals the intake pressure. The inlet valve then opens, and free air is admitted to the cylinder for the remainder of the return stroke. Thus the inlet capacity of the compressor is lowered without reducing the intake pressure. The Wickwire Mining Co.'s units being each two-stage machines, clearance space in the proper proportion is added simultaneously to both low and high pressure cylinders, thus maintaining a constant ratio of compression over the entire load range. This system of regulation is a very desirable one under conditions, such as those above mentioned, where electric power is purchased on the basis of a special maximum demand charge, as it permits the motor to be operated at a higher load factor than would otherwise be possible.

To further eliminate the necessity for peaks and hollows in its load curve, the company contemplates constructing an underground cham-

ber, below the mine sump, for storage of air, utilizing a column of water to give the effect of a hydraulic accumulator. This will enable the compressor to be run at constant speed, under practically ideal conditions of efficiency, and the hoist can then be operated by air, admitted to its cylinders, instead of steam, in a manner similar to those of the Oliver Iron Mining Co. at Iron Mountain, Mich., where compressed air is piped in from a distant plant operated by water power.

Davidson Compressor Station

Following the inspection of the Wickwire Mining Co.'s plant, the writer visited the new compressor station of the Davidson Ore Mining Co., north of Iron river, where the compressor is an Ingersoll-Rand P. E. machine of much larger capacity, having a delivery of 2,500 cubic feet per minute. Some additional facts brought out here, which were also true of the units previously described, relate to the very important details of valve mechanism, as bearing upon the efficiency.

In the first place, there appears to be no liability of the escape of clearance air, for the inlet valve cannot open until the clearance air has expanded to intake pressure. As the valve is very light and its lifts or travel very slight, there can be no shock on opening or closing, no battering and no undue wear.

The valve is double-ported, air entering the cylinder outside the ring valve and inside of it through the openings in the guide plate. With a very slight lift a very large inlet opening is afforded a wide annular space almost as large in diameter as the piston, and amounting to from 12 to 15 per cent of the total cylinder cross section.

The valve movement is positive; the valves must open and close. They are literally bathed in oil from the cylinder lubrication flowing down over the piston face. They cannot bind or stick. They are self-grinding for it is found that the ring turns around on the guide plate and practically never seats twice in succession in the same position.

The valve permits complete cylinder jacketing, thus not only improving the compression efficiency, but causing better lubrication and sustained tightness of all joints. The construction admits the coolest possible air to the cylinder, for the air enters through the inlet tube, which is cooled by contact with the head jacket. Moreover, the piston itself is cooled by the cylinder jacket. The air enters in a solid column through the tube and in the form of a cylinder through the ports, everywhere encountering cool metal, so that it cannot be perceptibly raised in temperature in the fraction of a second required for a stroke at full speed.

The large, unobstructed inlet passages and ports, and the quick-acting, fully-opening valves, admit a full cylinder of air at each stroke. As a result, the volumetric efficiency of the compressor is high. The simplicity of the valve movement, the lightness of the valves, their slight lift, and the large intake areas permit high speeds, without undue wear or loss of efficiency, so that the compressor has exceptionally large capacity for the small amount of floor space occupied.

The compressor at the Davidson mine, a unit similar to which will shortly be put in service at the Bengal mine, Palatka, Mich., of the Verona Mining Co., is driven by a Westinghouse synchronous motor of 400 horsepower capacity, 2,200 volts, at 150 revolutions per minute, with a 10-kilowatt exciter. Current from the Peninsular Power Co.'s mains is received through three 125-kilovolt-ampere, oil-cooled, Westinghouse transformers, and the circuit is protected by a Westinghouse lightning arrester. The usual switchboard and other auxiliary apparatus have been installed.

Use of Synchronous Motor

In the decision of various mining companies to adopt electrically-driven compressors, the use of the synchronous motor and its characteristic of building-up or equalizing the power factor of the system has played a leading part.

A synchronous motor will operate at any desired power factor. Varying the strength of the direct current exciting the field magnets, which can readily be done by an attendant while the machine is running, will cause a variation in the power factor. In this manner it cannot only be raised to any degree, but can be made to neutralize the effect of other apparatus having a lower power factor, thus bringing the value in the main transmission line and on the generator up to 100 per cent, irrespective of the deficiency in this respect of other apparatus.

The synchronous motor can be constructed to operate equally well on single phase, two-phase or three-phase circuits, with, of course, the proper winding in each case. When its fields are fully excited and it has been brought up to its rated speed, which can be done by a small induction or direct current motor mounted on the same shaft, or by a special winding on the rotor, current can be thrown on from the main supply as soon as synchronism is indicated by lamps or by a suitable instrument on the starting panel. Then, provided the speed of the main generator is suitably regulated, this type of motor will run at absolutely constant speed from no load up to a very heavy overload. Its use is generally restricted to a special service and large units, such as those described, owing to the fact that a direct current exciter must be provided and that in its simpler forms it is not self-starting, even under no load; but for the conditions of compressor service mentioned, it is practically an ideal machine, and its application in this direction is being rapidly extended.

Advances in Design of Railway Rolling Stock

The marked improvements that have been made of late years in the design and construction of railway rolling stock were pointed out forcibly by a demonstration train that the Santa Fe railroad recently ran over its lines. This train was composed of two locomotives, and two each of the various types of both freight and passenger cars, one of each being built in 1881 and the other in 1911. The locomotive probably shows the greatest development. The one built in 1881 weighed 133,000 pounds, with a drawbar pull of 14,000 pounds, compared with a weight of 850,000 pounds and a drawbar pull of 110,000 pounds for the locomotive built in 1911. The smokers and coaches also showed a great increase in size and capacity. The older smoker weighed 49,400 pounds and had a capacity of 28 passengers, against 86 passengers and a weight of 119,100 pounds for the newer type. The coach of 1881 weighed 50,300 pounds with a capacity of 48 passengers, whereas the modern coach weighs 123,100 pounds and seats 75 passengers. The development of this heavier rolling stock has been a direct outcome of the effort of the railroads to attract business by superior equipment, coupled with the demand of the public for greater comfort, higher speeds and greater safety.

Turbines were first introduced into marine vessels in 1894 when the steamship "Turbinia" was so equipped. Results since then have been so favorable that there is at present 6,000,000 horsepower of turbines installed in marine service, embracing war vessels, merchant marine and pleasure yachts.

Reversing Engine and Turbine Efficiency Tests

Comparison of the Relative Economy of the Two Machines for Driving a Blooming Mill, With Detailed Data on Rolling Ingots

By J A Knesche

A SERIES of tests on a reversing rolling mill engine was conducted recently in Germany by Dr. J. Puppe, the results of which no doubt will be of considerable interest to iron and steel works operators in this country and also to manufacturers and designers of power machinery for rolling mills, because at the present time there is little accurate data available on the power required for rolling steel in reversing mills. As reported by Dr. Puppe before a German engineering society, it was the intention to make these tests at a plant in which certain boilers furnish steam only to the reversing rolling mill engine. However, such an arrangement could not be found, and if such tests had been made they could not have been considered indicative of representative practice. For this reason a plant was selected for these tests in which, in addition to the reversing mill engine, other engines and pumps take steam from the same boilers that furnish steam to the reversing mill engine. Another interesting feature of these tests is that the reversing mill engine is operated in connection with a low pressure turbine.

J. A. Knesche

J. A. Knesche, who has had a wide experience in power plant engineering, particularly as relating to iron and steel manufacture, was born in Germany and came to this country in 1893, after four years' experience in field and shop work. He is a graduate from a liberal arts school and from the Iowa State College, where he received his degree in mechanical engineering. Later he made a special study of power problems at the School of Engineering, University of Wisconsin, and subsequently became instructor in mechanical engineering at the University of Tennessee and also at the Iowa State College. For a number of years he was associated with railroad construction companies and during the last seven years he has been employed as engineer of tests in a large metallurgical works in West Virginia. Mr. Knesche is the author of a number of technical papers on power problems and practice connected with the rolling of iron and steel.

The power house of the plant in which these tests were made contain 18 Babcock & Wilcox boilers, which have a total heating surface of 71,250 square feet. If we allow 10 square feet of heating surface per boiler horsepower, the total nominal horsepower capacity of this entire steam generating equipment would be 7,125 horsepower. As shown in Fig. 1 each pair of boilers has a brickwork setting in common, and for each of the three batteries of six boilers there is a brick stack, 236 feet high. Each group of six boilers has one economizer with a heating surface of 9,450 square feet, which was in use during the tests. All boilers are provided with superheaters having a total heating surface of 1,680 square feet.

To obtain accurate results it was necessary to make the duration of the tests as long as possible. Since the load on the boilers in iron and steel works fluctuates greatly, the tests were continued, day and night, over a period of 14 days. During two additional weeks, the coal and water evaporated were measured accurately to obtain reliable data representative of actual operating conditions. All coal was weighed on calibrated scales and from each scale load of coal a sample was taken for analysis; the coal was immediately crushed, mixed and spread out in a square, one-fourth of which was retained as a sample. This process was repeated until a sample of the proper size was obtained, which then was placed in jars with air-tight tops. A part of the sample was used in the de-

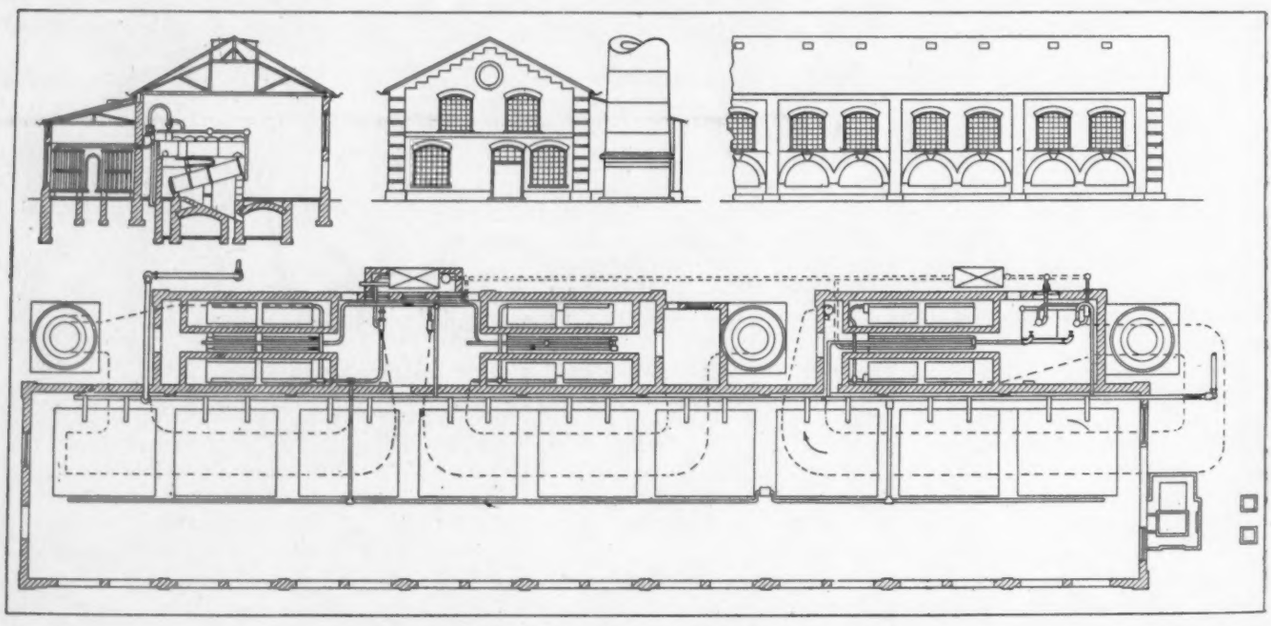


FIG. 1—GENERAL LAYOUT OF THE BOILER HOUSE

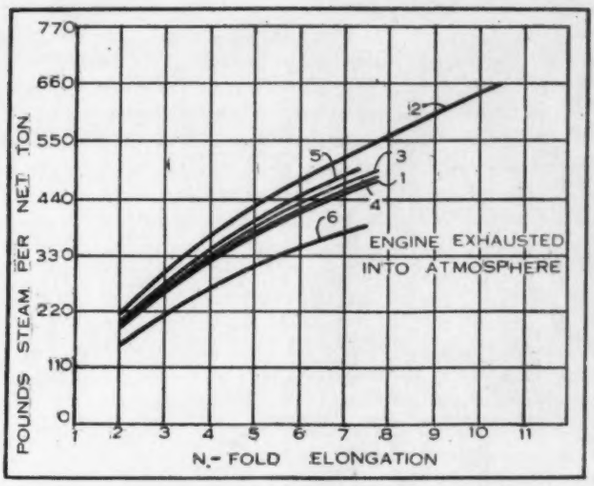


FIG. 2—STEAM CONSUMPTION CURVES

Data for these curves were obtained as follows: No. 1, Table IV; No. 2, Table V; No. 3, Table VI; No. 4, Table VII; No. 5, Table VIII; curve No. 6 represents an extra ingot with rolling temperature from 2,192 to 2,152 degrees Fahr.

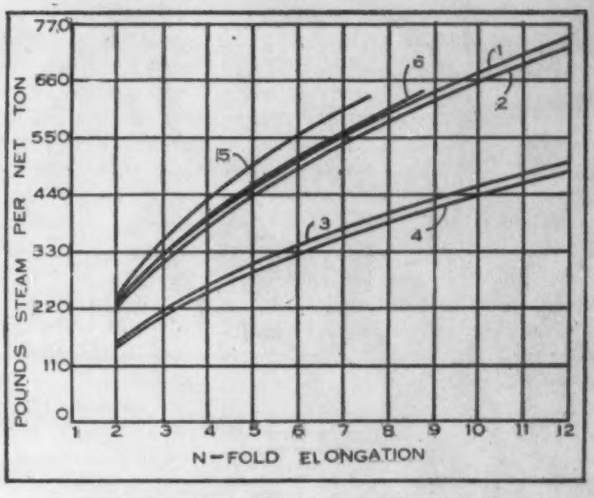


FIG. 3—STEAM CONSUMPTION CURVES

Curve No. 1, 7-hour test; No. 2, 9-hour test; Nos. 3 and 4, 7 and 9-hour tests, computed respectively from data for condensing engine; No. 5, shorter test while rolling rail steel, tensile strength from 92,500 to 102,000 pounds per square inch; No. 6, short test rolling Bessemer steel, tensile strength from 57,000 to 62,600 pounds per square inch.

termination of the moisture. The chemical analyses of the coal and the heat of combustion were determined at the Technical high school in Aachen, Germany. The average analyses of the coal are given in Table I.

Table I.

AVERAGE ANALYSES OF THE COAL TESTED.

	Per cent.	Per cent of combustible.
Proximate analysis:		
Fixed carbon	64.55	75.00
Volatile matter	21.58	25.00
Moisture	4.12	.....
Ash	9.75	.....
Ultimate analysis:		
Carbon	78.58	87.33
Hydrogen	5.15	5.73
Oxygen	4.17	4.65
Nitrogen	0.94	1.04
Sulphur	1.12	1.25
Ash	10.04	.....
		B. T. U. per pound.
Calorific value of fuel:		
Upper limit		13,440
Lower limit		12,935

The feed water was measured in calibrated water meters of standard type. This was the only possible method of determining the volume of water evaporated because of the large quantity required. Thus, the average amount of water used during the second week was 51.26 metric tons per hour. The greatest error found during the calibration was 0.5 per cent. In the boiler plant readings were taken every 15 minutes at the different points of observation in the manner usual in boiler testing. Computed results based on one 24-hour day are contained in Table III.

Oxygen Content of Flue Gases

The oxygen content of the flue gases was greater than the oxygen which actually entered the boiler furnaces, which was due to leakage into the economizers. Not all of the boilers were in operation and only those were used which were required to generate the necessary steam for the normal output.

The engine investigated is a twin-tandem compound machine, 43¼ and 61 inches by 51 inches stroke. The problem was to determine the energy used to drive the mill and the steam

Table II.

HEAT BALANCE.

	Per cent of total heat.
Heat used in:—	
Generation of steam	59.48
Superheating	5.69
Through economizers	5.02
Total	70.19
Heat lost:	
In waste gases	15.10
Through carbon in ash	4.02
Through radiation, soot, unburned gases	10.69
Total	100.00

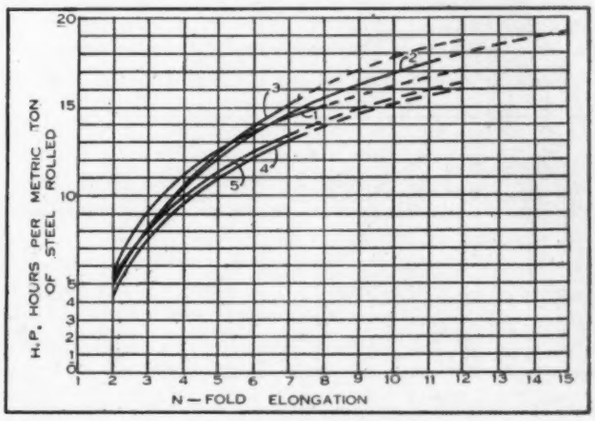


FIG. 4—ELONGATION CURVES

Curves from data in the following tables: No. 1, Table IV, temperature beginning of rolling 2,142 degrees Fahr. and end, 2,129 degrees Fahr.; No. 2, Table V, 2.142 to 2,104 degrees Fahr.; No. 3, Table VI, 2,129 to 2,078 degrees Fahr.; No. 4, Table VII, 2.205 to 2.179 degrees Fahr.; No. 5, Table VIII, 2,205 to 2,167 degrees Fahr.

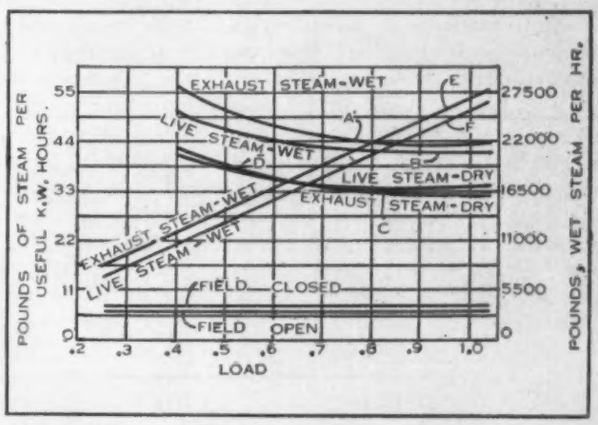


FIG. 5—OPERATING CURVES OF TURBINE NO. 2

A and *B*, steam consumption per kilowatt-hour, wet steam, and *C* and *D*, dry steam; *E* and *F*, hourly steam consumption, and *G* and *H*, hourly steam consumption under friction load of entire machine; average steam pressure in receiver with live steam, ½ pound, exhaust steam, 2 pounds.

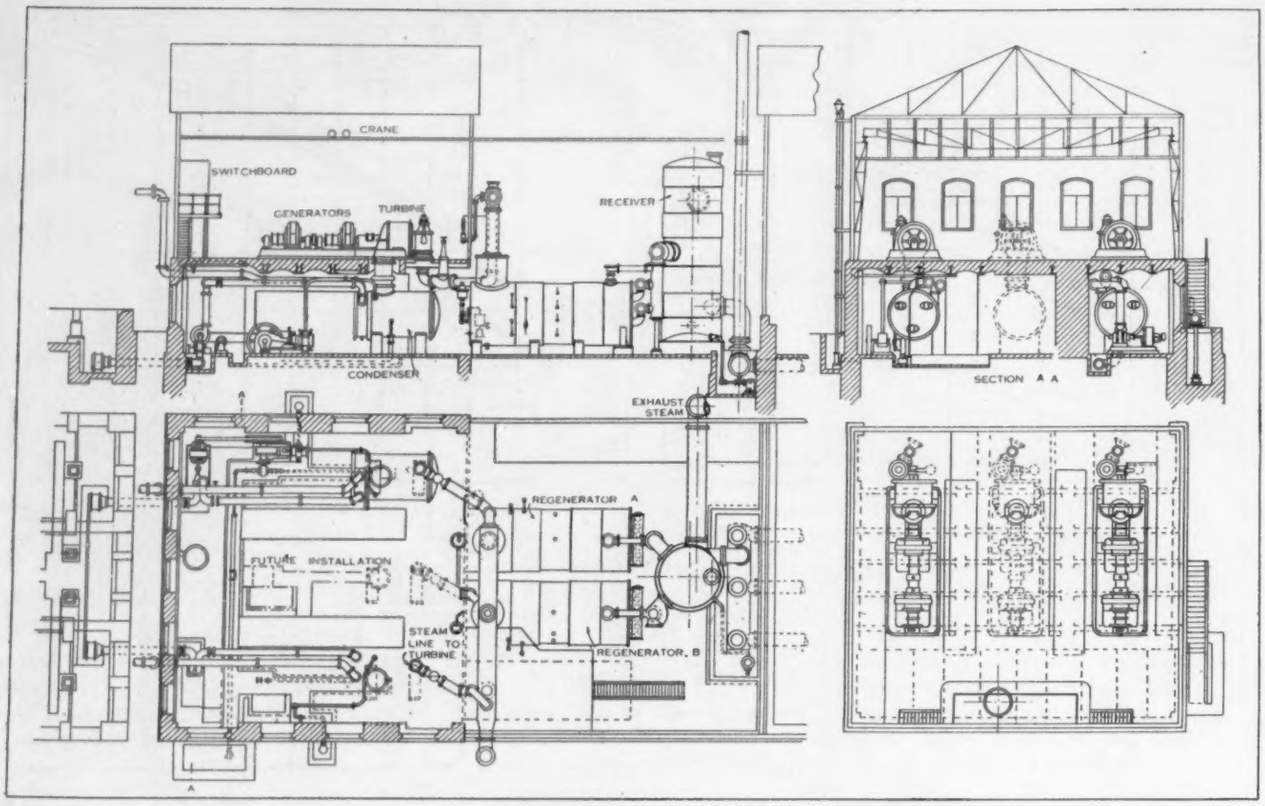


FIG. 6—GENERAL LAYOUT OF LOW PRESSURE TURBINE STATION

required by the engine for rolling individual ingots and for operations extending over various periods of time. The ordinary continuous indicator was not used in this work because the expansion lines of the different diagrams often form a tangle of unintelligible curves. On the indicator diagrams made, Fig. 7, there is a series of dots the upper row of which represents second marks and the lower row the end of the stroke or center points of the engine. All these points were made automatically by electrically-operated devices. A meter was used to measure the steam sent to the engine. The recording device of the steam meter used is actuated electrically by the difference in the mercury levels in a U-tube, the difference in levels being caused by the flow of steam past pitot tubes. During the test the temperature of the steam was taken at its entrance into the high pressure cylinder, between the high and low-pressure cylinders and on the exhaust side of the low-pressure cylinder. The average temperature of the steam one day was 477 degrees Fahr. at the boilers, 425 degrees Fahr. at the high-pressure cylinder, 270 degrees Fahr. at the receiver and 227 degrees Fahr. on the exhaust side of the low-pressure cylinder. These were the usual temperatures during the test.

Column 16, in Tables IV to VIII represents the steam consumption for each pass from the time the engine started to the time it stopped operating. These figures, of course, are different from the steam consumption data for actual rolling. From the data bearing on each respective pass in column 26 the writer has worked out a quantity which, in similar tests conducted by him in 1907, he called constant *C*. This constant is the work required to bring about a reduction of cross-sectional area of one square inch for a length of one foot and it makes possible at once a comparison of the work done in the different passes. The average constant for the entire ingot is also given. The importance of this constant does not seem to be generally understood, but since it is in use in some of the largest iron and steel works in this country, its adaptability to practical application seems to be established.

Fig. 2 shows the steam consumption for different elongations of the ma-

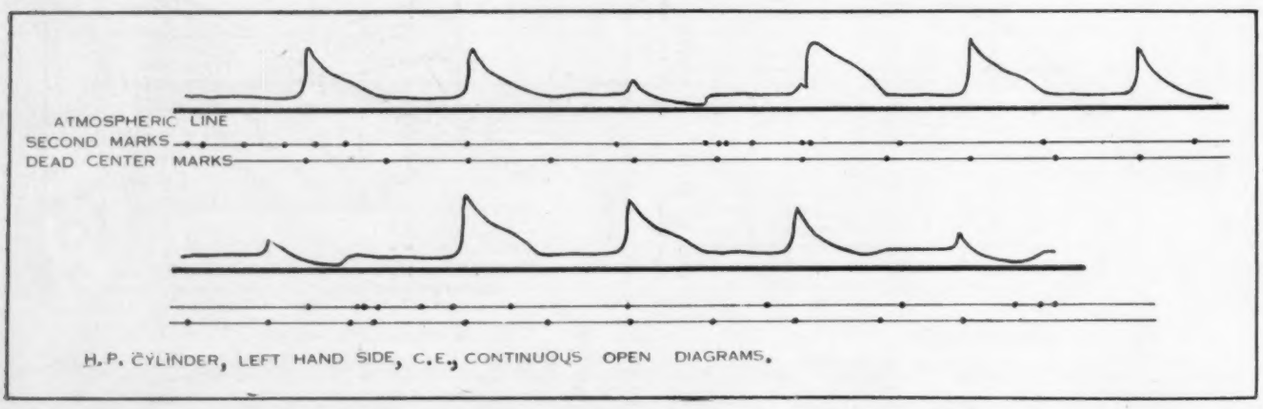


FIG. 7—INDICATOR DIAGRAM OF TWIN-TANDEM, COMPOUND ENGINE

terial rolled. Curves *1* to *5* represent the rolling data of the ingots given in Tables IV to VIII. During these tests the engine operated in connection with the low-pressure turbine. Considering the difference of rolling temperature and the manner of operating the engine, there is a remarkable coincidence between these curves. The manner of operating the engine, of course, influences the steam consumption. If the engine is operated during the intervals between passes, the steam consumption for the ingot will, of course, be higher than if the engine does not operate during these intervals. The back-pressure on the engine is also of importance in the steam consumption. The average back-pressure was 17.2 pounds absolute during the rolling of ingot No. 1 while it was 21.6 pounds during the rolling of ingot No. 2 and 18.5 pounds absolute during the rolling of ingot No. 3. Curve *6*, Fig. 2, represents the steam consumption of the engine during the rolling of an ingot when the engine exhausted into the atmosphere. The much lower steam consumption was due to better conditions, including higher rolling temperature and freer exhaust, with the back-pressure practically down to atmospheric pressure.

Effect of Back-Pressure

To determine how much more steam the engine required when operated in connection with the turbines, a great many tests were made with different back-pressures on the engine. These back-pressures were varied by loading differently the blow-off valves on the steam regenerators; several runs also were made with the engine exhausting into the atmosphere. From these tests it was found that for the different back-pressures in the low-pressure cylinders and for the same engine loads, there also were different steam consumptions. As already stated, the steam consumption is lowest with atmospheric exhaust. With normal operating conditions and with a back-pressure of from 2 to 4 pounds it was found that the engine required from 10 to 12 per cent more steam than when the engine exhaust was permitted to escape into the atmosphere. With changing back-pressure, the work done in the low-pressure cylinder also varied accordingly. Thus, in one case, where the back-pressure was 1.71 pounds gage, the load on the low-pressure cylinder was 50.79 per cent of the total load, while in another case where the average back-pressure was 6.75 pounds the load on the low-pressure cylinder was 35.73 per cent of the total load.

The curves in Fig. 2 show the steam consumptions for the individual ingots. While these curves are interesting, they can not be used in arriving at the steam consumption of the engine under a given elongation. To arrive at a fair average figure for the steam consumption of the engine when rolling continuously a certain size of material, two tests were made; the first was seven and the second nine hours in duration. During these tests the engine was operated in conjunction with the turbines. The results of these tests are graphically illustrated in Fig. 3. In this chart it will be noticed that the curves for given elongations are higher, that is, they show a greater steam consumption than the corresponding curves in Fig. 2. The explanation is that in continuous operations, delays in rolling occur during which the engine cylinders cool off, thus increasing the steam losses to a considerable extent; furthermore, it is natural when the test is short, such as that of a single ingot, that the man in charge of the engine will operate more carefully than when the test is of long duration.

In table IX are given data on the seven and nine-hour tests. During the nine-hour test soft Bessemer steel was rolled which had a tensile strength of from 57,000 to 62,000 pounds per square inch. During the seven-hour test, in addition to the 99 soft Bessemer ingots, 12 open-hearth ingots were rolled, the tensile strength of which was practically the same as that of the Bessemer ingots, but they were rolled at a lower temperature than the Bessemer ingots. This is perhaps the chief reason why the curve of the seven-hour test, Fig. 3, lies higher than the curve of the nine-hour test. Another reason for the higher steam consumption in curve *1* is that the average back-pressure on the engine during the test corresponding to this curve was 5.77 pounds while the average back-pressure during the test corresponding to curve *2* was somewhat less; furthermore, the average superheat of the steam for curve *1* was 102 degrees Fahr., while for curve *2* it was 126 degrees Fahr. The average temperatures of the ingots were practically the same in the two tests with the exception of the 12 open-hearth ingots, which were rolled at about 122 degrees Fahr. lower temperature than the Bessemer ingots.

The steam consumption, computed from curves *1* and *2*, Fig. 3, is 601.5 and 560.5 pounds, respectively, for an 8-fold elongation. Curves *3* and *4* were computed from curves *1* and *2*. The better position of curves *3* and *4* is explained by the 10 per cent saving realized when the engine exhausted into the atmosphere as compared with leading the exhaust steam into the low-pressure turbine, and by a further saving of 25 per cent when the engine operated condensing. In this manner the curves *3* and *4* show, with an 8-fold elongation, an average steam consumption of 405 and 394 pounds, respectively, or an average for both tests of about 400 pounds. Figures similar to these have already been obtained in actual practice by Ortmann, who found for an 8.1-fold elongation a steam consumption of 393 pounds per metric ton of steel rolled. He obtained these results with a compound condensing engine driving a blooming mill.

Table III.

BOILER HOUSE DATA.

Average atmospheric temperature, degrees Fahr.	59
Average temperature in boiler house, degrees Fahr.	64
Average feed water in metric tons per hour	31.21
Average temperature of cold feed water, degrees Fahr.	59
Average temperature of hot feed water, degrees Fahr.	153
Average temperature of waste gases before entering economizer, degrees Fahr.	543
Average temperature when leaving economizer, degrees Fahr.	424
Average CO_2 in flue gases, per cent.	9.5
Average O in flue gases, per cent.	12.4
Average temperature of steam, degrees Fahr.	536
Average absolute steam pressure, pounds.	138
Average draft above fires in boiler furnace in inches of water.	0.12
Average draft on chimney side of economizer in inches of water.	1.14

In Fig. 4 is shown the horsepower required for rolling the ingots, the data and results of which are given in Tables IV to VIII, inclusive. The energy required for the elongation includes, in this case, the work required for the friction load and the work for accellerating the engine and the rolls. The influence of temperature is plainly shown by these curves. Curves *4* and *5* occupy a better position because of the higher temperatures than curve *1*, *2* and *3*. From these curves it also will be noted that the quality of the material has no influence on rolling. Curve *2* represents the data obtained in rolling rail steel and this curve is located between curves *1* and *3*, which represent the data obtained in rolling two soft, Bessemer steel ingots. The temperatures of the three ingots represented by these data were practically the same. It is rather remarable that these curves in-

Table IV.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1—Number of pass															
2—Duration of pass, seconds	1.47	1.4	1.95	1.95	1.48	2.52	2.44	2.35	2.63	3.0	2.51	3.95	3.81	4.02	5.94
3—Interval between passes, seconds	4.62	8.51	5.97	4.26	4.16	11.78	3.59	4.68	4.62	5.35	7.65	11.76	4.62	25.71	....
4—Operating time of engine, seconds	8.03	4.21	5.06	7.58	3.51	5.02	4.98	4.15	4.15	7.52	5.36	6.67	6.88	7.76	8.02
5—Revolutions per minute beginning	30	10	50	40	90	30	20	45	145	95	115	30	80	40	60
6—Revolutions per minute end	100	125	80	100	70	80	30	90	25	100	60	70	80	85	115
7—Average revolutions per minute	63	97	78	99	120	83	79	103	114	109	109	113	101	127	122
8—Maximum revolutions per minute during pass.	132	126	98	123	138	116	108	114	145	117	128	146	127	140	142
9—Average indicated horsepower	2,200	4,390	3,174	4,597	4,006	3,726	3,591	3,126	4,016	3,620	4,438	5,396	3,450	2,708	1,786
10—Maximum indicated horsepower	2,200	4,390	3,174	4,800	4,104	4,642	3,720	3,440	4,212	3,800	5,110	6,360	4,420	3,078	2,526
11—Work from beginning of one pass to beginning of next, horsepower seconds	3,234	6,146	6,189	8,964	5,929	9,390	8,762	7,346	10,562	10,860	11,139	21,314	13,145	10,886	10,609
12—Cumulative work during passes, horsepower sec.	3,234	9,380	15,569	24,533	30,463	39,853	48,615	55,961	66,524	77,384	88,523	109,837	122,983	133,869	144,479
13—Average friction load, indicated horsepower	190	292	260	330	400	276	264	344	380	364	364	376	340	424	407
14—Work during friction load, horsepower seconds	280	409	507	644	592	696	694	808	999	1,092	914	1,485	1,326	1,704	2,417
15—Actual work done on steel, horsepower seconds	2,954	5,737	5,682	8,320	5,337	8,694	8,118	6,538	9,563	9,768	10 225	19,829	11,819	9,182	8,192
16—Steam consumption from beginning of one pass to beginning of next, horsepower, seconds	59.81	59.05	54.82	67.83	55.21	59.42	53.46	56.45	75.82	91.07	101.32	145.05	144.37	99.75	186.91
17—Cumulative steam consumption	46.58	118.86	173.67	241.51	296.71	356.14	409.60	466.05	541.87	632.94	734.26	879.31	1,023.67	1,123.42	1,310.33
18—Dimensions of material rolled	16.81 x	15.63 x	16.30 x	14.69 x	13.07 x	11.50 x	15.35 x	13.78 x	12.28 x	10.63 x	10.28 x	7.12 x	8.43 x	6.14 x	6.30 x
19—Reduction of height in inches	17.91	18.11	15.83	16.02	16.22	16.42	11.65	11.81	11.97	12.13	10.75	10.91	7.28	7.44	6.30
20—Sectional area, square inches	0-2.87	1.18-.12	0-3.96	1.61-1.06	1.61	1.57	1.06	1.57	1.50	1.65	1.85	3.15	2.48	2.28	1.14
21—Difference in area	300.10	283.69	256.39	235.31	212.02	188.63	178.93	162.75	147.10	128.90	110.44	77.71	61.36	45.70	39.68
22—Elongation of original length	18.75	16.41	27.30	21.08	23.29	23.28	9.80	16.18	15.74	18.12	18.46	32.73	16.35	15.66	6.02
23—Length in feet	1.058	1.119	1.239	1.350	1.498	1.683	1.775	1.952	2.161	2.464	2.876	4.088	5.177	6.952	8.007
24—Displaced volume cubic inches	5.74	6.06	6.71	7.31	8.12	9.12	9.62	10.57	11.71	13.35	15.58	22.15	28.05	37.66	43.37
25—Temperature, degrees, Fahr	1,147.71	1,129.34	1,986.94	1,698.47	2,044.50	2,267.53	1,072.70	1,867.79	1,997.19	2,546.18	2,957.33	6,120.98	4,345.48	5,272.90	2,721.11
26—Constant, C., in foot pounds	2,142	2,142	2,142	2,142	2,154	2,154	2,142	2,142	2,129	2,129	2,142	2,142	2,129	2,129	2,129
	14,880	28,439	16,828	29,292	15,310	22,215	46 712	20,739	28,146	21,906	19,634	14,838	11,800	8,446	17,022

REVERSING ENGINE AND TURBINE EFFICIENCY TESTS

Average constant, C, equal to 20.487 foot-pounds for entire ingot; tests were made on rail steel with a tensile strength of 103 116 pounds per square inch. Analysis: Carbon, 0.37 per cent, phosphorus, 0.052 per cent. Section of ingot: Upper end 15.748 inches square, bottom end, 19.685 inches square; weight, 5 808 pounds. Ingot was edged after the 2d, 6th, 10th, 12th and 14th passes. Elongation based on original length of 5.417 feet. Ingot remained 53 minutes in soaking pit.

Table V.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1—Number of pass																	
2—Duration of pass, seconds	1.04	1.35	1.39	1.36	1.87	1.71	2.49	2.51	2.32	2.35	3.16	4.14	3.53	5.6	5.9	5.22	7.78
3—Interval between passes, sec.	5.56	11.86	6.35	3.97	5.51	13.88	4.03	2.96	5.19	23.02	4.18	8.46	3.45	5.12	8.61	26.61	....
4—Operat'g time of engine, sec.	5.23	4.52	5.47	5.78	4.49	5.4	4.38	5.23	5.64	4.17	5.14	8.33	8.56	8.9	7.36	8.49	13.75
5—R. P. M. beginning	35	45	50	20	20	25	20	20	25	15	15	35	20	40	30	25	110
6—R. P. M. end	90	110	75	60	75	60	50	50	100	60	75	75	90	80	40	70	100
7—Average R. P. M.	68	67	63	80	93	90	90	94	100	100	100	89	108	83	103	125	102
8—Max. R. P. M. during pass.	90	115	100	110	130	125	130	135	155	160	150	130	165	110	145	160	115
9—Average I. H. P.	1,370	2,446	3.666	3,218	3,900	3,200	3,915	4.742	4,048	4,486	4,959	4,052	3,800	2,712	2,252	2,204	1,789
10—Max. I. H. P.	1,370	2,446	3,666	3,218	4,166	3,468	4,520	4,960	4,302	4,830	5,646	4,500	4,292	3,040	2,994	3,032	2,560
11—Work from beginning of one pass to beg. of next, H. P. sec.	1,425	3,302	5,095	4,376	7,293	5,472	9,748	118.02	9,475	10,542	15,670	16,775	13,414	15,188	11,260	11,505	13,918
12—Cumulative work during passes, H. P. seconds	1,425	4,727	9,822	14,198	21,491	26,963	36,711	48,513	57,988	68,530	84,200	100,975	114.389	129,577	140,837	152,342	166,260
13—Av. friction load, I. H. P.	227	223	210	267	310	300	298	312	332	332	332	297	360	277	343	415	340
14—Wk. dur. fric. load, H. P. sec.	236	302	292	363	580	513	745	782	770	780	1.050	1,230	1,270	1,550	1,715	2,166	2,642
15—Ac. wk. done steel, H. P. sec.	1,189	3,000	4,803	4,013	6,713	4,959	9,003	11,020	8,705	9.762	14,620	15,545	12,144	13,638	9,545	9,339	11.276
16—Steam consump. fr. beg. of 1 pass to beg. of next, H. P. sec.	12.48	48.51	59.24	47.07	64.63	56.27	100.	01 68.51	84.71	91.55	171.26	147.13	148.37	130.84	138.90	160.21	239.83
17—Cumulative steam consump.	12.48	83.03	142.27	191.34	255.97	312.25	401.23	480.77	565.02	567.03	828.29	976.41	1,124.78	1,255.63	1,394.53	1,554.73	1,794.56
18—Dim. of material rolled	16.81 x	15.63 x	16.30 x	14.67 x	13.07 x	11.18 x	15.16 x	13.50 x	12.05 x	10.63 x	9.45 x	7.20 x	8.98 x	6.89 x	6.34 x	5.16 x	4.92 x
19—Reduc. of height in inches	17.91	18.11	15.83	16.02	16.22	16.42	11.34	11.50	11.65	11.81	10.79	10.94	7.36	7.52	7.05	7.20	5.31
20—Sectional area, sq. inches	0-2.87	1.18-.12	0-3.98	1.61-1.06	1.61	1.89	1.26	1.57	1.54	1.42	2.36	2.24	1.97	2.09	1.18	1.18	1.89
21—Difference in area	300.19	283.87	256.40	235.31	212.02	183.56	171.86	156.15	140.39	125.55	101.82	78.85	66.09	51.81	44.67	37.15	28.25
22—Elong. of original length	17.56	16.32	27.47	21.10	23.29	28.45	11.70	15.72	15.75	14.84	23.62	23.07	12.77	14.28	7.14	7.51	8.91
23—Length in feet	1.058	1,119	1,239	1,349	1,498	1,730	1.848	2.034	2.262	2.530	3.117	4.029	4.807	6.132	7.112	8.550	11.247
24—Displaced volume, cubic in.	5.71	6.03	6.68	7.28	8.08	9.33	9.96	10.97	12.20	13.64	16.80	21.72	25.92	33.06	38.34	46.09	60.63
25—Temp., degrees, Fahr	1,135.93	1,117.80	1,989.20	1,691.39	2,034.43	2,758.47	1,309.83	1,879.69	2,073.98	2,173.23	3,867.91	4,653.05	3,328.82	4,441.07	2,832.51	3,456.63	4,929.13
26—Avg. constant C., in ft. lbs.	2,142	2,142	2,129	2,129	2.142	2,142	2,129	2,129	2,116	2,116	2,129	2,129	2 104	2,104	2,116	2,116	2,104
	6,433	16,538	14,200	14,173	15,932	10,135	41,913	34,671	24,577	26,163	19,813	16,830	19,904	15,672	18,916	14,636	11,322

The material was Bessemer steel with a tensile strength of 60 736 pounds per square inch. Analysis: Carbon, 0.06 per cent, and phosphorus, 0.068 per cent. The top section of the ingot was 15.748 inches square and the bottom, 19.685 inches square; weight, 5,779.4 pounds. The ingot was edged after the 2d, 6th, 10th, 12th, 14th and 16th passes. Elongation based on original length of 5.39 feet. Ingot remained 65 minutes in soaking pit. The average constant, C, is equal to 18,510 foot-pounds for the entire ingot.

Table VI.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1—Number of pass.....																	
2—Duration of pass, sec.....	0.93	2.1	1.88	2.84	2.49	3.26	3.32	3.42	4.06	3.34	4.38	4.37	6.86	5.78	8.6	7.62	7.98
3—Interval between passes, sec.	2.8	18.8	3.78	4.3	4.4	4.3	4.32	13.20	3.9	3.86	3.98	1.30	6.25	9.3	5.1	10	....
4—Operating time of eng. sec.	6.4	4.2	5.4	5.4	5.4	5.7	5.20	6.4	7	4.4	6.6	5.5	10.20	8.4	11	9.6	11.2
5—R. P. M. beginning.....	100.3	36.4	52.0	20.8	42.5	38.2	24.70	36.1	40.7	8.5	6.2	6.3	19.7	30.7	12.4	34.2	30.5
6—R. P. M. end.....	66.7	50.2	38.3	42.2	79.7	80.5	60.20	52.4	35.3	42.2	80.1	58.3	72.8	94.2	38.6	55.4	74.2
7—Average R. P M.....	81.6	53.6	42.6	37.3	51.1	47.1	4.46	47	42	64.3	65.5	62	43.5	62.7	50	64.1	63.7
8—Max. R. P. M. during pass.	100	67	52	59	80	80	73	75	74	93	74	83	65	94	69	84	84
9—Average I. H. P.....	1,910	1,605	1,690	1,594	1,790	1,760	1,650	1,940	2,195	1,965	1,980	2,230	2,000	2,920	1,760	1,650	1,535
10—Max. I. H. P.....	1,932	1,628	1,704	1,594	1,940	1,782	1,792	2,222	2,308	2,282	2,140	2,560	2,238	3,246	1,940	1,920	1,680
11—Work from beg. of 1 pass to beginning of next, H. P. sec.	1,776	3,370	3,177	4,527	4,457	5,738	5,478	6,635	8,912	6,563	8,673	9,745	13,730	16,878	15,136	12,573	12,250
12—Cumulative work during passes H. P. sec.....	1,776	5,146	8,323	12,850	17,307	23,045	28,523	35,158	44,070	50,633	59,306	69,051	82,771	99,649	114,605	127,178	139,428
13—Avg. friction load, I. H. P.	272	179	142	125	171	157	154	157	140	205	218	207	145	209	167	214	213
14—Wk. dur. fric. load, H. P. sec.	252.96	375.9	266.96	355	425.79	511.82	511.28	536.96	568.40	684.7	954.84	904.59	994.7	1.208.02	1,436.2	1,630.68	1,699.74
15—Ac. wk. done. st'l, H. P. sec.	1,523.04	2,994.1	2,910.04	4,172	4,031.21	5,226.18	4,966.72	6.098.06	8,343.60	5,878.3	7,718.16	8,840.41	1,2725.3	15,669.98	13,699.8	10,942.32	10,550.26
16—Steam consump. fr. beg. of 1 pass to beg. of next, H. P. sec.	50.64	29.06	37.57	27.38	47.22	47.09	42.00	53.90	70.06	57.19	80.58	72.75	103.59	135.54	119.11	100.90	116.62
17—Cumulative steam consump.	50.64	79.70	117.26	135.83	191.87	238.96	280.95	334.86	405.12	462.11	542.68	615.44	719.03	854.57	973.68	1,074.59	1,192.21
18—Dimen. of material rolled..	16.46 x 17.91	15.28 x 18.11	16.65 x 15.46	15.55 x 15.67	14.17 x 15.87	12.99 x 16.06	11.81 x 16.26	10.65 x 16.46	14.80 x 10.91	13.35 x 11.06	11.73 x 11.22	10.20 x 11.38	9.13 x 10.35	6.73 x 10.51	8.46 x 6.89	7.32 x 7.05	5.75 x 7.48
19—Reduc. of height in inches..	0-3.23	1.18-.47	0-3.62	1.10-.28	1.38	1.18	1.18	1.06	1.65	1.46	1.61	1.54	2.24	2.40	2.05	1.14	1.30
20—Sec. area sq. inches.....	294.79	277.40	257.13	243.68	224.87	208.69	192.05	176.88	161.44	147.65	131.64	116.02	94.57	70.77	58.32	51.61	43.00
21—Difference in area.....	22.96	17.39	20.27	13.46	18.80	16.18	16.65	15.17	15.44	13.78	16.01	15.62	21.44	23.81	12.45	6.40	8.61
22—Elongation of original length	1.077	1.145	1.235	1.303	1.412	1.512	1.653	1.795	1.967	2.150	2.412	2.737	3.358	4.488	5.446	6.154	7.387
23—Length in feet.....	5.43	5.77	5.23	6.57	7.12	7.67	8.34	9.06	9.92	10.85	12.17	13.81	16.94	22.64	27.47	31.04	37.26
24—Displaced volume, cu. inch..	1,389.43	1,134.22	1,404.75	1,006.47	1,483.00	1,383.51	1,533.36	1,518.40	1,678.26	1,641.46	2,084.36	2,281.21	3,553.56	4,839.35	3,382.35	2,212,96	3,270.44
25—Temp., degrees Fahr.....	2,129	2,129	2,104	2,104	2,091	2,091	2 078	2,078	2,104	2,104	2,104	2,104	2,091	2,391	2,078	2,078	2,078
26—Avg. constant C., in ft. lbs.	6,627	16,190	12,502	25,994	16,337	22.844	19,411	24,223	29,553	21,263	21,489	22,233	22,042	15,770	21,731	29,881	17,841

Bessemer steel, tensile strength 95,152 pounds. Chemical analysis: Carbon, 0.35 per cent, and phosphorus, 0.06 per cent; section, top end, 15.748 inches square, bottom end, 19.685 inches square; weight, 5,505 pounds. Ingot was edged after 2d, 8th, 12th, 14th and 16th passes. Elongation is based on original length of 5.053 feet. Ingot remained 1 hour, 34 minutes in soaking pit. Average constant, C, equal to 21,583 foot-pounds for entire ingot.

Table VII.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1—Number of pass.....																	
2—Duration of pass, seconds...	1.31	2.39	1.57	2.56	2.64	2.51	2.51	3.01	3.38	2.81	3.16	3.73	5.61	5.69	5.88	9.93	8.92
3—Interval between passes, sec.	3.58	13.30	4.83	4.00	4.29	4.33	3.52	14.05	4.07	4.12	4.16	8.57	4.48	9.96	10.73	7.04	....
4—Operating time of eng., sec.	5.18	4.76	5.50	6.04	5.82	4.78	6.96	4.42	7.28	4.35	6.37	7.22	12.25	9.64	14.14	17.53	12.32
5—R. P. M. beginning.....	34.00	10.00	52.00	51.00	18.00	54.00	14.00	42.00	54.00	34.00	50.00	19.00	32.00	30.00	28.00	40.00	14.00
6—R. P. M. end.....	9.80	58.00	77.00	64.00	82.00	48.00	82.00	40.00	68.00	54.00	70.00	62.00	70.00	24.00	82.00	38.00	16.00
7—Average R. P. M.....	54.20	46.20	59.00	47.30	44.10	53.30	70.40	55.50	45.00	64.20	63.00	64.80	48.50	54.00	64.00	45.00	53.00
8—Max. R. P. M. during pass.	108.00	77.00	77.00	75.00	87.00	84.00	90.00	85.00	93.00	95.00	95.00	85.00	84.00	90.00	94.00	80.00	72.00
9—Average I. H. P.....	1,684	2,166	1,778	1,572	1,933	1,840	1,880	2 324	2,533	2,284	2,148	2,000	2,558	3,175	2,315	1,800	1,100
10—Max. I. H. P.....	1.684	2,166	1,778	1,572	1,950	1,840	2,040	2,454	2,728	2,372	2,234	2,453	2,916	3,728	2,704	1,936	1,238
11—Work from beg. of 1 pass to beg. of next, H. P. sec.....	2,205	5,154	2,790	4,024	5,100	4,620	4,720	6,990	8,560	6,415	6,785	7,455	10,435	10,807	10,362	10,787	9,800
12—Cumulative work during passes, H. P. sec.....	2,205	7,359	10,149	14,173	19,273	23,893	28,13	35,603	44,163	50,578	57,363	64,818	75,253	86.060	96,422	107,209	117,009
13—Avg. fric. load, I. H. P.....	180	153	196	1p6	145	167	234	184	149	213	209	215	161	180	212	150	177
14—Wk. dur. fric. l'd, H. P. sec.	236	366	308	323	383	420	587	553	503	598	660	802	903	1,024	1,248	1.489	1,578
15—Ac. wk. done st'l. H. P. sec.	1,969	4,788	2,482	3,701	4,717	4,200	4,133	6,437	8,057	5,817	6,125	6,653	9,532	9,783	9,114	9,298	8,220
16—Steam consump. from beg. of 1 pass to beg. of next. H. P. sec.	55.84	33.02	38.47	39.59	43.29	38.04	58.82	43.91	77.20	59.79	63.43	81.48	76.74	114.37	114.30	106.67	98.11
17—Cumulative steam consump.	55.84	88.97	127.44	166.45	209.73	247.76	306.58	350.49	427.69	487.47	550.86	632.39	709.22	823.49	937.78	1,044.45	1,142.56
18—Dimen. of material rolled...	16.46 x 17.99	15.28 x 18.19	16.65 x 15.47	15.55 x 15.67	14.29 x 15.87	13.11 x 16.06	11.81 x 16.26	10.67 x 16.46	14.80 x 10.83	13.31 x 10.91	11.73 x 11.14	10.24 x 11.30	9.29 x 10.87	7.09 x 11.02	9.07 x 7.24	7.40 x 7.40	5.71 x 7.56
19—Reduction of height in in.	0-3.23	1.18-.63	0-3.62	1.10-.43	1.26	1.18	1.30	1.14	1.65	1.50	1.57	1.50	2.01	2.20	1.97	1.65	1.69
20—Sectional area, sq. inches...	296.09	278.36	257.39	243.68	226.75	210.59	192.05	175.58	160.27	145.12	130.72	115.66	100.53	78.12	65.60	54.78	43.15
21—Difference in area.....	24.13	17.73	20.97	13.72	16.93	16.16	18.54	16.46	15.31	15.15	14.40	15.06	14.70	22.84	12.52	10.81	11.63
22—Elongation of original length	1.080	1.150	1.244	1.313	1.412	1.520	1.666	1.823	1.997	2.206	2.449	2.768	3.172	4.099	4.882	5.845	7.421
23—Length in feet	5.26	5.60	6.05	6.39	6.87	7.40	8.10	8.87	9.72	10.74	11.92	13.47	15.43	19.95	23.75	28.44	36.11
24—Displaced volume cu. inch.	1,409.75	1,112.92	1,408.9	996.52	1,298.54	1,332.48	1,644.02	1,602.72	1,630.35	1,767.69	1,855.77	2,153.51	2,376.37	4,231.09	2,998.11	3,082.83	3,970.27
25—Temp., degrees Fahr.....	2,205	2,205	2,205	2,205	2,179	2,179	2,167	2,167	2,192	2,192	2,179	2,179	2 179	2,179	2,179	2,179	2,179
26—Constant, C., in ft. lbs.....	8,416	26,160	10,613	22,901	22,001	19,054	14,930	23,918	29,373	19,395	19,358	17,792	22,798	11,647	16,650	16,406	10,618

Bessemer steel with tensile strength of 95,100 pounds per square inch. Chemical analysis: Carbon, 0.36 per cent, and phosphorus, 0.054 per cent. Ingot, upper section, 15.905 inches square, bottom end, 19.685 inches square; weight, 5,269 pounds. Ingot edged after 2d, 8th, 12th, 14th and 16th passes. Elongation based on original length of 4.866 feet and remained in soaking pit 1 hour, 42 minutes.

Table VIII.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1—Number of pass.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2—Duration of pass, seconds...	1.82	2.17	2.64	3.05	2.9	3.66	4.07	5.19	3.12	3.89	4.81	5.02	5.96	7.82	8.28	8.81	13.8
3—Interval between passes, sec.	3.63	12.02	5.48	5.17	4.47	5.4	3.65	12.7	5.28	3.93	5.15	14.5	5.29	16.50	4.77	12.65	....
4—Operating time of eng., sec.	8.95	6.42	8.22	7.14	7.12	6.88	6.99	8.5	7.71	6.9	5.61	84.9	11.45	11.43	11.13	11.47	19.68
5—R. P. M. beginning.....	36	8	36	32	18	12	37	23	32	10	10	49	16	31	14	28	22
6—R. P. M. end.....	48	65	50	72	51	54	58	67	34	76	20	72	76	88	65	74	58
7—Average R. P. M.....	35.4	37.7	28	36.2	33.5	30.8	32	31.8	38.5	53.5	42.0	47	40.5	45	44	50.5	35
8—Max. R. P. M. during pass.	80	62	48	76	53	58	60	76	70	80	65	75	75	86	62	72	55
9—Average I. H. P.....	871	1,594	1,149	1,478	1,172	1,230	1,300	1,250	1,673	1,886	1,378	1,514	2,290	1,700	1,537	940	753
10—Max. I. H. P.....	871	1,594	1,149	1,478	1,172	1,296	1,356	1,314	1,756	1,500	1,448	1,542	2,380	1,806	1,586	992	814
11—Wk. from beg. of 1 pass to beg. of next, H. P. sec.....	1,585	3,460	3,035	4,508	3,400	4,502	5 292	6,488	5,220	7 340	6,630	7,600	136,50	13,294	12,730	8,285	9,810
12—Cumulative work during passes, H. P. sec.....	1,585	5,045	8,080	12,588	15,988	20,490	25,782	32,270	37,490	44 830	51,460	59,060	72,710	86,004	98 734	107,019	116,829
13—Avg. friction load, I. H. P.	118	124	94	120	112	102	136	105	128	178	140	156	134	150	146	168	116
14—Wk. dur. fric. l'd. H. P. sec.	215	269	248	366	325	374	472	545	400	693	674	783	799	1,173	1.209	1,480	1,517
15—Ac. w'k done st'l H. P. sec.	1,370	3,191	2,787	4,142	3,075	4,128	4,860	5,943	4,820	6,647	5,956	6,817	12,851	12,121	11,521	6,805	8,293
16—Steam consump. from beg. of 1 pass to beg. of next, H. P. sec.	39.65	35.31	41.34	44.32	41.53	46.89	46.08	56.28	73.49	66.34	65.07	79.35	112.78	121.40	115.38	100.77	124.24
17—Cumulative steam consump..	39.65	74.97	115.91	160.23	201.76	248.65	294.73	351.01	424.51	490.84	555.91	635.26	748.04	869.43	984.82	1,085.59	1,209.83
18—Dimen. of material rolled...	16.46 x 15.28 x 17.91	16.65 x 18.11	15.51 x 15.47	14.29 x 15.67	13.15 x 15.87	11.97 x 16.06	10.79 x 16.26	14.80 x 16.46	13.39 x 10.94	11.97 x 11.10	10.39 x 11.18	9.13 x 11.34	7.01 x 10.55	8.74 x 10.71	7.40 x 7.17	5.79 x 7.32	7.56
19—Reduc. of height in inches...	0-3.23	1.18-.47	0-3.62	1.14-.31	1.22	1.14	1.18	1.18	1.42	1.42	1.42	1.57	2.20	2.13	1.97	1.34	1.54
20—Sectional area, sq. inches....	294.79	277.24	257.01	243.06	226.75	211.22	194.61	177.52	162.02	148.61	133.82	117.85	96.37	75.04	62.63	54.20	43.75
21—Difference in area	22.96	18.84	20.23	13.96	16.31	15.53	16.62	17.08	15.51	13.40	14.79	15.97	21.46	21.33	12.42	8.43	10.45
22—Elong. of original length.....	1.078	1.146	1.236	1.307	1.433	1.504	1.632	1.790	1.961	2.138	2.374	2.696	3.298	4.235	5.074	5.864	7.265
23—Length in feet.....	5.39	5.73	6.18	6.53	7.00	7.52	8.16	8.96	9.80	10.69	11.87	13.48	16.48	21.16	25.36	29.30	36.30
24—Displaced volume, cu. inch..	1,370.69	1,217.54	1 390.65	1,034.85	1,278.83	1,305.38	1,499.73	1,672.89	1,664.69	1,577.24	1,897.39	2,274.92	3,473.54	4,218.82	3,154.31	2,564.54	3,676.43
25—Temp., degrees, Fahr.....	2,205	2,205	2,192	2,179	2,179	2,179	2,168	2 168	2,168	2,168	2,179	2,179	2,192	2,192	2,168	2,168	2,168
26—Avg. constant, C., in ft. lbs..	6,006	16,129	12 094	24,649	14,611	19,175	19,441	21 067	17,203	25,173	18,410	17.179	19,713	14,569	19,844	14,947	11,860

Bessemer steel, tensile strength, 95,152 pounds per square inch. Chemical analysis: Carbon 0.34 per cent and phosphorus, 0.052 per cent. Top end of ingot 15.748 inches square and bottom, 5.685 inches square; weight, 5,859 pounds. Ingot was edged after 2d, 8th, 12th and 14th passes. Elongation based on original length of 5.007 feet. Ingot remained 68 minutes in soaking pit. Average constant, C, equal to 16,512 foot pounds for entire ingot.

tersect in contradistinction to the steam consumption curves in Figs. 2 and 3. The reason for this is that ingot No. 1 was comparatively cool on the outside while the steel inside still had a high temperature. Therefore, curve 1 rises considerably at the beginning and then flattens rapidly. The steel on the interior of ingot No. 3 was colder than that on the outside. Therefore, curve 3 rises at first in a normal manner, but as rolling proceeds it inclines rapidly to the vertical. This difference is explained by the fact that ingot No. 1 was in the soaking pit only 54 minutes, while ingot No. 3 remained 94 minutes in the pit. Therefore the decline in temperature during rolling was 19 degrees Fahr. for ingot No. 1, and 82 degrees Fahr. for ingot No. 3; ingots Nos. 2, 4 and 5 showed temperature drops of 66, 68 and 70 degrees Fahr., respectively.

The steam consumption per indicated horsepower-hour is of special interest. It was difficult to obtain figures which agreed in all cases, because of the back-pressure on the engine, which, as has been shown, varied between 1.5 to 7.5 pounds. After making many computations in which large, medium and small diagrams were worked up and after allowing 25 per cent for steam loss from condensation and leakage, the diagrams gave 29.78, 31.25 and 34.2 pounds of steam per indicated horsepower, or an average of 31.74 pounds. Another method is to take the total steam as shown in Tables IV to VIII, inclusive, and to divide the total steam by the total work done in each case. If we use this method we obtain 32.65, 38.82, 30.80, 35.18 and 37.30 pounds of steam per indicated horsepower-hour, or an average for all ingots of 34.95 pounds.

Investigation of Low-Pressure Turbine

The low-pressure turbine station was designed to make use of 55,000 pounds of exhaust steam per hour; it consists of two low-pressure turbines, each having a rated capacity of 1,000 horsepower. Each turbine drives two 330-kilowatt, direct-connected generators. The dynamos of one turbine generate current at 250 volts and those of the other at 500 volts. Most of the current generated in the turbine station is used for lighting purposes. The two Rateau steam regenerators are equipped with automatic operating valves so that no water can flow from the regenerators to the exhaust main in case of a vacuum in the latter. In addition to the usual equipment in a station of this kind, there is a water level regulator used at

each regenerator and also an oil extractor.

In case the pressure rises over 6.5 pounds in the accumulator, a safety valve automatically releases the excess of steam. If the pressure drops to 1.5 pounds, live steam is permitted to enter through a pressure reducing valve. Each turbine unit is equipped with a surface condenser and the pumps are motor-driven.

The exhaust steam passes first into the receiving vessel, then into the two regenerators, which are piped in such a manner that both may furnish steam to one turbine operating alone, or to both turbines operating at the same time. The steam then passes through the turbines and is condensed. At present a third low-pressure turbine installation is being made which is to be used as a reserve unit. The steam for the turbine station is furnished by the following machines: Two rolling mill engines, each 10,000 horsepower maximum load, one only operating at a time; the blooming mill reversing engine on which the tests were made, 10,000-horsepower capacity, and two hydraulic pressure pumps, each 180-horsepower.

It should be stated that these ratings are never realized. The average horsepower output of the blooming mill engine during the tests described was only 2,460-horsepower. The average for each of the rolling mill engines was 3,477-horsepower.

Moisture in Steam

Before giving the data of the tests on the above equipment a device should be described which was used for the determination of the moisture in the low-pressure steam. As a rule, the quantity of the condensed water on the exhaust side of the turbines is taken as the measurement of the steam consumption of the low-pressure turbines. This method is not strictly correct because it does not take into account the quality of the steam. The figure representing the number of pounds of steam used in low-pressure turbines, should be given in dry steam because according to operating conditions there always is contained, in the low-pressure steam, a considerable amount of moisture. For this reason a device was used which served to determine the moisture content of the steam. It consisted of a cylindrical vessel, containing about 1,750 pounds of cold water, which was closed on all sides and was thoroughly insulated to prevent the radiation of heat. A glass showing the height of water, two thermometers and a stirrer to insure a steady circulation, completed the equipment of this apparatus. The steam entered through the top of the vessel and condensed after coming into contact with the surface of the cold water, thereby increasing the temperature of the water. The total quantity of cold water present being known, the number of pounds of steam necessary to increase the temperature of the water can be computed readily. However, the water in the vessel was increased by the moisture in the steam, and to make accurate computations, the following method was employed.

$$x = \frac{(W_k - W_d)\, q_1 - W_k\, q_o - W_d\, q}{W_d\, r}$$

where

x = the dry steam led into the vessel.

W_k = the weight of the cold water before the test.

W_d = the weight of the steam and moisture.

q = the heat of the liquid of this mixture corresponding to the steam pressure.

q_1 = the heat of the water in the vessel after the condensation of the steam.

q_o = the heat of the water in the vessel before the condensation of the steam.

r = the latent heat of evaporation of the water at the existing pressure.

With this apparatus continuous data were taken for the determination of the moisture in the steam and the average values were found to be as follows: Fifteen per cent of moisture with throttled live steam; 21.8 per cent with exhaust steam, and 15.8 per cent with a mixture of live and exhaust steam. The moisture was measured in the steam line at a point directly in front of the receiving tank. Only on the basis of dry steam is it posible to compare the operation of different low-pressure turbines and the purpose of the test on the machine of the type was to determine the steam consumption under different loads. In Tables X and XI the results of these tests are given. The data of low-pressure turbine operations with exhaust steam are noted in Table X and Table XI gives the results of operations with live steam. The steam consumption per useful kilowatt-hour is shown in Fig. 5. A study of these curves will show, in an interesting manner, the relation existing between steam consumption, load, steam pressure and moisture in steam. It also will be noted that the vacuum is greatest with the smallest load, that is, where the quantity of steam used in the turbine is smallest.

Table IX.

SEVEN-HOUR TEST.

No. of item.	No. of ingots.	Finished section, square inches.	Weight, metric tons.	Length in feet at Beginning.	Length in feet at End.	Elongation of original length.
1	19	5.314 × 5.314 = 28.249	49.150	96.511	1,134.40	11.754
2	12	5.709 × 5.709 = 32.589	28.700	58.920	574.19	9.745
3	5	5.905 × 5.905 = 34.875	13.250	26.524	247.71	9.339
4	30	6.89 × 6.102 = 42.044	77.410	152.797	1,200.44	7.859
5	2	6.299 × 6.299 = 39.68	5.300	10.857	87.08	8.021
6	32	7.087 × 7.087 = 50.22	83.100	166.237	1,078.86	6.490
7	11	9.449 × 5.905 = 55.80	29.090	58.254	339.90	5.835
.	111	....	286.000	570.100	4,662.593	8.179
Total steam used, pounds						174,170
Steam consumption per net ton of steel rolled, pounds; with an 8-fold elongation					608.99 =	601.35
Condensation in steam jackets, pounds						1,217.59
Condensation in steam jackets, per cent of total						0.699

Bessemer steel, tensile strength from 56 890 to 62,580 pounds per square inch. with the exception of 12 open-hearth ingots in item No. 2. Top section ingot 15.748 inches square, bottom 19.685 inches square. Steam gage, 133.5 pounds; temperature entering steam, 424.75 degrees Fahr.; superheat, 102 degrees Fahr.; back pressure on engine, 5.75 pounds.

NINE-HOUR TEST.

No. of item.	No. of ingots.	Finished section, square inches.	Weight, metric tons.	Length in feet at Beginning.	Length in feet at End.	Elongation of original length.
1	9	5.314 × 5.314 = 28.249	24.480	48.073	565.01	11.753
2	4	6.299 × 6.299 = 39.68	11.200	21.527	184.03	8.549
3	22	8.268 × 8.268 = 68.355	56.950	112.433	543.21	4.831
4	80	7.087 × 5.314 = 36.27	205.950	406.424	3,702.18	9.109
	112	....	298.580	588.457	4,994.43	8.487
Total steam used, pounds						179,873
Steam consumption per net ton of steel rolled, pounds; with an 8-fold elongation					602.428 =	582.505
Condensation in steam jackets, pounds						696.74
Condensation in steam jackets, per cent of total						0.387

Bessemer steel, tensile strength from 56,890 to 64,003 pounds per square inch. Steam gage, 127.89 pounds; temperature of entering steam, 445 degrees Fahr.; superheat, 125 degrees Fahr.; back pressure on engine, 5.34 pounds; ingot same section as 7-hour test.

Relative Economies

The relative economy of the condensing reversing engine, or a reversing engine with a low-pressure turbine can not be given in a general way, since the construction and the manner of operating the machines, the condition and length of the exhaust line, the operating conditions of the entire works, etc., will greatly influence the results.

If it is assumed, in the tests under

Table X.

TESTS ON TURBINE II WITH EXHAUST STEAM

No. of test.	Length of time, min.	Generators. Volts.	Generators. Amperes.	Generators. K. W.	Load, per cent.	For Condensing pumps, K. W. hours.		Useful,	Steam consumption, lbs. During entire test.	Per K. W. hr.	Total per 1 hour.	Avg. abs. steam press., lbs., in the receiver.	at the first turbine wheel.	Vacuum inches of Hg.	R. P. M. of turbine.
1	30	259.1	1,108.0	287.1	43.5	143.5	25	118.5	6,415.39	54.14	12,830.77	18.64	7.42	28.27	1,530
2	60	261.6	1,235.0	323.1	49.0	323.1	50	273.1	13,955.12	51.10	13,955.12	17.26	8.03	28.24	1,528
3	120	259.7	1,270.6	330.0	50.0	660.0	100	550.0	27,910.24	50.75	13,955.12	17.24	8.22	28.24	1,528
4	90	253.1	1,347.2	341.0	51.7	511.5	75	436.5	21.627.13	49.56	14,418.08	18.67	8.38	27.83	1,528
5	60	253.9	1,358.4	344.9	53.3	344.9	50	294.9	13,955.12	49.56	13,955.12	18.61	8.44	27.83	1,528
6	60	268.5	2,173.4	583.5	88.4	583.5	50	533.5	23,346.71	43.76	23,346.71	16.61	12.97	27.35	1,516
7	120	267.2	2,304.2	615.7	93.3	1,231.4	100	1,131.4	49,669.64	43.89	24,834.82	15.17	13.09	27.32	1,516
8	60	267.6	2,361.7	632.0	95.8	632.0	50	582.0	25,496.20	43.81	25,496.20	15.35	13.16	27.29	1,515
9	180	267.8	2,390.6	640.2	97.0	1,920.6	150	1,770.6	76,984.63	43.47	25,661.54	16.64	13.80	26.84	1,509
10	60	268.7	2,386.7	641.3	97.2	641.3	50	591.3	25,859.96	43.74	25,859.96	16.02	13.88	26.78	1,510
11	120	267.5	2,499.2	668.5	101.3	1,337.0	100	1,237.0	53,756.97	43.45	26,878.48	16.66	14.21	26.78	1,508
12	60	265.3	2,613.3	693.3	105.0	693.3	50	643.3	28,042.51	43.58	28,042.51	15.88	14.64	26.63	1,499

The average moisture in the steam was 21.8 per cent before it entered the receiver and 24.5 per cent between receiver and turbine.

consideration, that the reversing blooming mill engine, when operating in conjunction with the low-pressure turbine, requires 1,000 pounds of steam for the performance of a certain amount of work, then the same engine performing the same work under the same conditions, but exhausting into the atmosphere, would require 900 pounds of steam because of the absence of the back-pressure on the engine. A compound condensing engine requires about 25 per cent less steam than an engine exhausting into the atmosphere so that the steam requirement of the compound condensing engine would become $900 \times 0.75 = 675$ pounds of steam. This steam requirement is 325 pounds less than that of the reversing blooming mill engine when operating in conjunction with the low-pressure turbine. If we assume, in a first class, high-pressure turbine installation the production of a kilowatt-hour with 15.4 pounds of steam we could produce with the above 325 pounds of steam, $325 \div 15.4 = 21.10$ kilowatt-hours.

If, on the other hand, we use the exhaust steam from the reversing engine in a low-pressure turbine, we would lose, of the 1,000 pounds of steam sent to the compound reversing mill engine, 15 per cent in condensation in the engine, steam lines, oil extractor and in the receiver; with the remaining 850 pounds of wet steam it would be possible, under full load, to produce $850 \div 43.45 = 19.6$ kilowatts, which is about 7 per cent less than the amount which could be produced in the high-pressure turbine. This somewhat unfavorable showing in the low-pressure turbine might be offset, to a certain extent, by enlarging the exhaust main and the receiver so as to reduce the back-pressure to some extent. On the other hand, the steam losses in the low-pressure turbine installation, in normal operation, are considerable, because, during the heavy working of the engine the safety valves on the regenerators will be open more or less and, in addition, during the delays in rolling, live steam will have to be throttled for use in the low-pressure turbine, the quantity of which may fluctuate between wide limits during the usual operation of the mill. Since 41.55 pounds of live steam per kilowatt-hour are required in the low-pressure turbine as against 15.4 pounds in the high-pressure installation, this loss, even though it may not occur frequently, must be taken into consideration. This source of loss may be avoided, of course, by the use of mixed-flow turbines.

In conclusion it should be stated that these investigations and results may be considered as normal, average figures; no effort was made to obtain special test results. The plant was taken as it was found and it was operated as usual while the test was in progress.

Hydraulic Mining on Cuyuna Range

The first hydraulic mining on the Cuyuna range, in Minnesota, is said to have been started recently. The equipment consists of two 100-horsepower motors, each connected with duplex pumps delivering 2,000 gallons of water per minute under a pressure of 50 pounds. The dirt is carried away in a large flume. It is reported that the company expects to handle as much material with these two pumps as could be done with two steam shovels.

The Brooklyn bridge was built of high grade steel at a time when little, of any, steel was used in structural work. The steel work in the bridge was reamed with a tapered, fluted reamer with a flexible shaft and the accuracy of the punching was such that reaming was considered necessary only to clean out the holes.

Table XI.

TESTS ON TURBINE II WITH LIVE STEAM

No. of test.	Length of time, min.	Generators. Volts.	Generators. Amperes.	Generators. K. W.	Load, per cent.	For Condensing pumps, K. W. hours.		Useful,	Steam consumption, lbs. During entire test.	Per K. W. hr.	Total per 1 hour.	Avg. abs. steam press., lbs., in the receiver.	at the first turbine wheel.	Vacuum inches of Hg.	R. P. M. of turbine.
1	30	249.2	1,127.7	281.0	42.6	140.5	25	115.5	5,754.01	49.82	11,508.01	20.19	7.16	28.18	1,530
2	60	252.0	1,138.4	286.9	43.5	286.9	50	236.9	11 640.29	49.15	11,640.29	21.17	7.20	28.18	1,530
3	90	253.0	1,171.1	296.3	44.9	444.5	75	369.5	17,923.40	48.50	11,948.93	18.77	7.38	28.18	1,529
4	30	255.0	1,236.7	315.4	47.8	157.7	25	132.7	6,256.65	47.16	12,513.31	16.02	7.70	28.15	1,526
5	180	248.8	1,286.1	320.0	48.5	960.0	150	810.0	37,963.21	46.87	12.654.40	18.82	7.82	28.12	1,527
6	60	245.7	1,415.0	347.7	52.7	347.7	50	297.7	13,611.20	45.72	13,611.20	18.08	8.58	28.01	1,525
7	30	256.9	1,556.2	399.8	60.6	199.9	25	174.9	7,724.92	44.16	15.449.84	19.85	9.20	27.92	1,523
8	90	262.9	1,926.6	506.5	76.7	759.7	75	684.7	29,100.72	42.50	19,400.48	18.82	10.86	27.77	1,520
9	30	266.3	1,930.0	514.0	77.9	257.0	25	232.0	9,814.88	42.31	19,629.76	21.17	10.77	27.67	1,516
10	60	264.0	1,951.8	515.3	78.1	515.3	50	465.3	19,762.03	42.46	19,762.03	18.82	10.92	27.74	1,520
11	90	267.5	2,459.0	657.8	99.7	986.7	75	911.7	38.029.35	41.71	25,352.90	17.96	13.38	27.23	1,514
12	60	267.1	2,496.8	666.9	101.0	666.9	50	616.9	25,701.23	41.67	25,701.23	19.70	13.55	27.17	1,513

The average moisture in the steam was 15 per cent before it entered the receiver and 18.5 per cent between receiver and turbine.

Efficiency Management in a Gas Tractor Plant

How Work is Scientifically Routed in the Works of the Hart-Parr Co., Which Embrace Foundries, Machine and Erecting Shops and Other Departments

SPECTACULAR growth has been a feature of the agricultural machinery business since its inception, but nothing in the early history of this great industry is comparable with the tremendous strides made in the gas tractor field in the past few years. In scarcely less than half a decade the production of gasoline and oil-driven tractors for farm purposes has increased from practically nothing to over 10,000 machines annually. The gas tractor has not only been successful in competing with the steam-driven traction engine in its peculiar fields, but also has developed possibilities of its own which seem to be capable of almost indefinite expansion.

The growth of this business has resulted in the creation of a number of large plants in the central west devoted to the manufacture of gas tractors. Among these, the works operated by the Hart-Parr Co., Charles City, Ia., are probably the most extensive. The Hart-Parr Co. is the outgrowth of a partnership formed in the middle nineties, between C. W. Hart and C. H. Parr, two young graduates of the University of Wisconsin. The initial plant at Charles City was built in 1901. In 1902 the first Hart-Parr gasoline tractors designed for threshing and other kinds of belt work and for general farm cultivation were marketed. Among the mechanical improvements which have made the gas tractor possible, and in the development of which the Hart-Parr Co. has been a pioneer, should be mentioned the oil cylinder cooling system and the perfection of a motor which will operate on kerosene and other lower grade fuels. The oil-cooling system was originated in 1898 after a large amount of experimental work.

Use of Low Grade Fuel

The water-cooled gas engine or tractor for agricultural work, especially in a northern climate, has certain inherent disadvantages, chief among which is the danger from freezing in cold weather. The earlier Hart-Parr tractors used gasoline, but its increasing price and scarcity compelled a substitute to be found. In response to this demand experiments were instituted and in 1905 the Hart-Parr Co. succeeded in perfecting a satisfactory method for using the lower grades of fuel. It consists of a peculiar carburetor in which a slight quantity of water is fed with the kerosene. The temperature of the combustion within the engine cylinder decomposes the water into its original elements, hydrogen and oxygen, and the latter combines with the free carbon, which otherwise would be deposited in the engine as soot.

The Hart-Parr factory occupies a wedge-shaped plot of ground 1 mile in length, ½ mile in width on the east side and 400 feet on the west, situated between the main lines of the Chicago, Milwaukee & St. Paul and the Illinois Central railways, in the town of Charles City. The larger portion of this great area of land is vacant at the present time, but has been acquired to provide for future extensions. The buildings now constructed occupy a strip approximately 2,600 feet long and averaging 460 feet in width at the western end of the property. The plant comprises ma-

FIG. 1—MAIN AISLE IN THE MACHINE SHOP, SHOWING THE ARRANGEMENT OF BAYS AND MACHINE NUMBERS

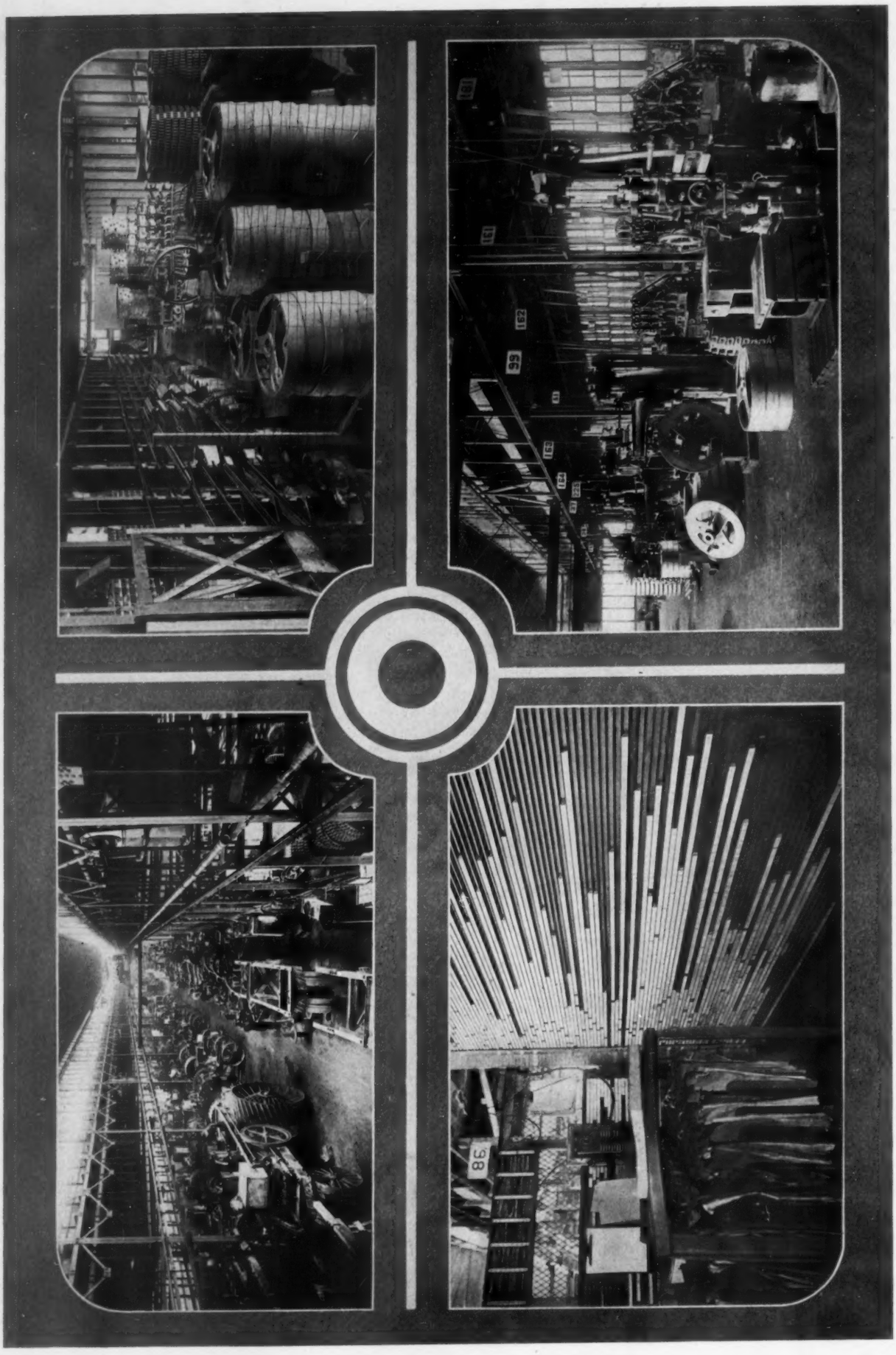


FIG. 3—STORE ROOM ADJACENT TO THE MACHINE SHOP

FIG. 5—THE DRILLING DEPARTMENT IN THE MACHINE SHOP

FIG. 2—A VIEW OF THE ERECTING DEPARTMENT

FIG. 4—THE PLANNING BOARD

chine and erecting shops, open-hearth steel and gray iron foundries and power testing and heating plants. The arrangement and dimensions of the principal buildings are indicated in Fig. 3. Those shown in dotted outline are proposed, while the full lines indicate buildings now constructed. In a general way it may be stated that the raw material is received at the south and east and progresses through the plant toward the north and west to the erecting shop from which the finished machines are shipped. The plant now has a capacity of 30 tractors of various sizes per week.

Before considering the detailed description of the plant, it is desirable to discuss a few of the general policies which have been adopted by this concern to facilitate production, encourage efficiency and insure a square deal for the workmen. These policies include the wage fixing system and the work routing method, together with the planning board, trucking and tool account systems.

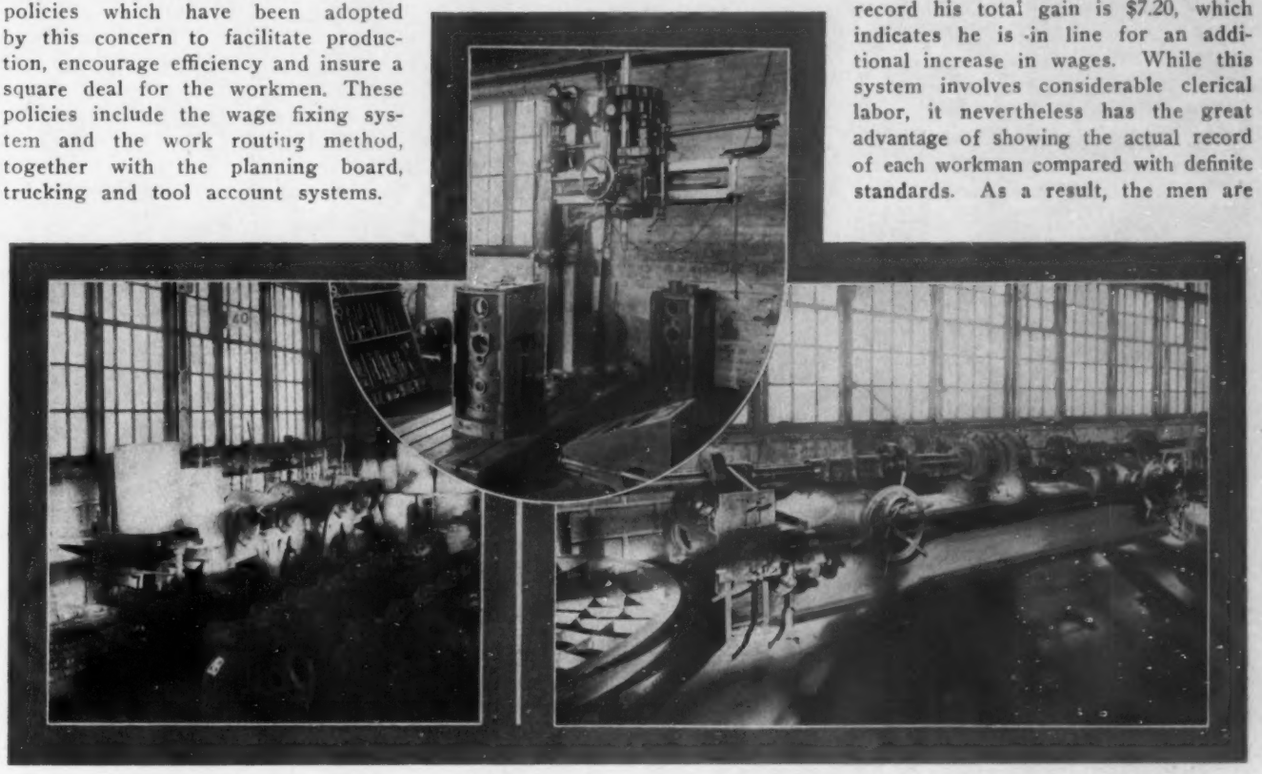


FIG. 6—A CYLINDER JIGGED FOR DRILLING

FIG. 7—CYLINDER TESTING BENCH

FIG. 8—LARGE CYLINDER BORING MACHINE

The management of the Hart-Parr Co. is not in favor of the piecework system of labor payment as usually applied. It has, therefore, worked out a wage payment system which aims to embody the chief advantage of the piecework plan—incentive to production—at the same time avoiding its disadvantages and some of its demoralizing features. The Hart-Parr Co. keeps an individual account of the performance of each workman on a card, illustrated in Fig. 28. This gives the details of the man's work week by week, including his actual time on each job, his earned hourly rate based on the standard cost of labor per job, his actual wage rate and the actual job cost. His loss or gain compared with standard conditions also is entered on the card, and the record given in the loss and gain columns determines the man's fitness for increases in wages.

Curves are plotted showing the average time required for each of the various operations included in the production of a tractor and from these curves, together with time studies, a set of standards indicating the proper cost of each operation are made up. All of the men work by the day, no piecework being permitted. Each man's daily wage is compared with the standard costs as indicated in Fig. 28, and adjustments are made accordingly.

The details of this method of handling the wage problem may best be described by referring to a specific example. The first line in Fig. 28 contains the record of a job on a 60-horsepower engine No. 4694. The standard cost of labor for this job, as determined from the curve sheets and time studies is $13.20, as given in the seventh column, under *Standard Cost of Labor.* The actual time of the workman on the job was 46 hours; his earned hourly rate, given in the adjacent column is, therefore, $13.20.—the standard cost—divided by 46, or 28.6 cents per hour. The man, however, is being paid 29 cents an hour and the actual cost of the job to the Hart-Parr Co. is 46 × 29 = $13.34. This is 14 cents in excess of the standard cost of $13.20, and the man is charged with a loss of 14 cents. On the next job, on engine No. 4681, the loss is the same, making the total loss to date 28 cents, as given in the *total loss* column at the right. On the third job, however, the man shows a distinct gain of $2.18, which offsets the total loss and leaves a total gain in his favor of $1.90. Subsequent losses and gains follow until finally the man's record shows a gain of $3.20 and his wage rate is changed from 29 to 30 cents an hour. At the conclusion of this record his total gain is $7.20, which indicates he is in line for an additional increase in wages. While this system involves considerable clerical labor, it nevertheless has the great advantage of showing the actual record of each workman compared with definite standards. As a result, the men are encouraged to do their best because they know that favorable results will bring about an immediate reward; also they are absolutely relieved from the petty tyranny of foremen which frequently occurs in large shops. In fact the personal equation does not enter into the question of a man's advancement; he is judged entirely by his actual record.

Considerable attention has also been given to the factory order system. Orders originate with the production department for the manufacture of tractors in lots of 100 machines. Each lot bears an individual consecutive number. The actual shop orders are

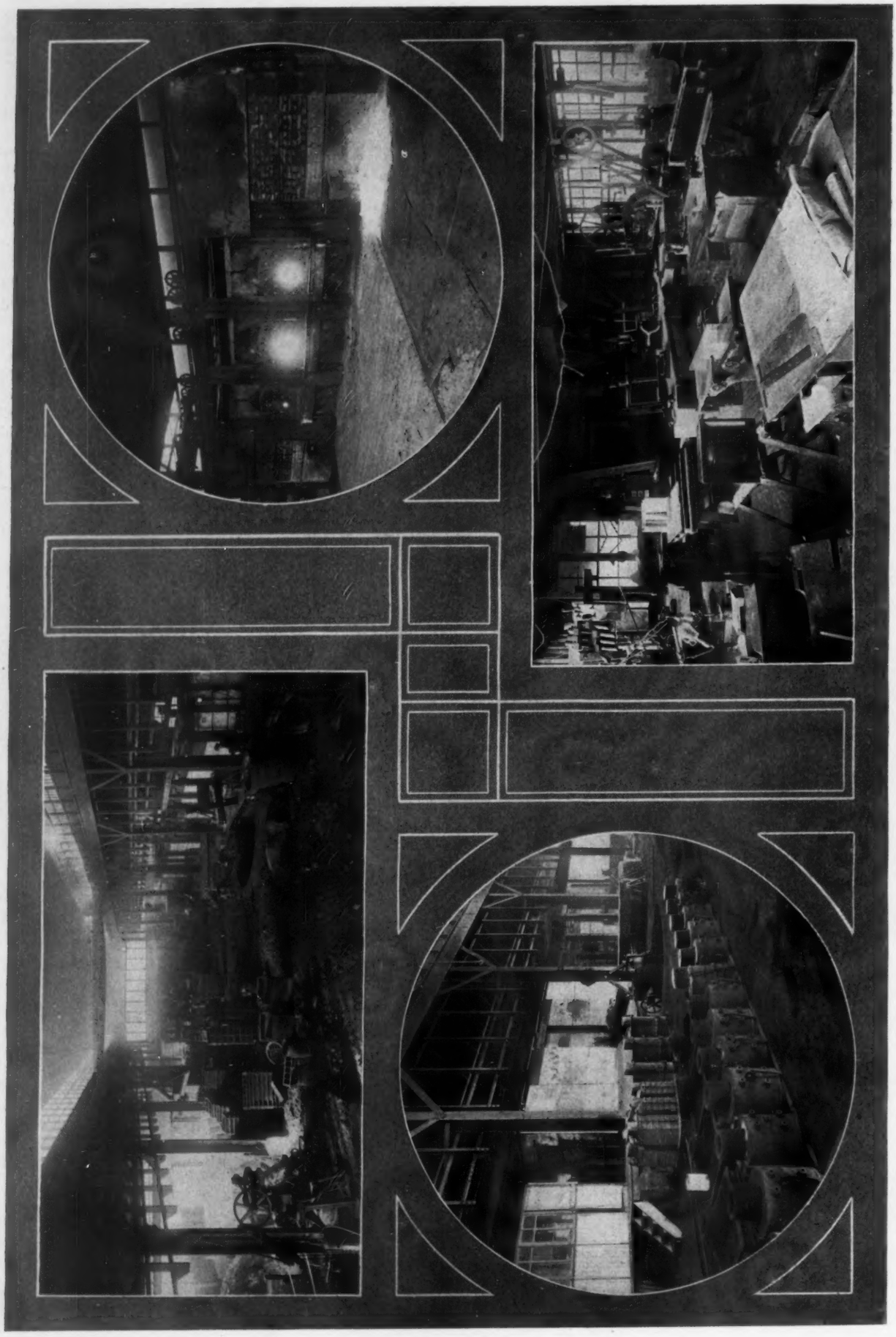


FIG. 9—MAIN BAY OF THE STEEL FOUNDRY

FIG. 10—CHARGING SIDE OF OPEN-HEARTH FURNACE

FIG. 11—POURING SIDE OF 10-TON OPEN-HEARTH FURNACE

FIG. 12—THE PATTERN SHOP

made up in blueprint form on sheets of a standard size, 9 x 12 inches. The print contains a drawing of the part together with instructions for the necessary machine operations. On the back of the print is a form in which the time record is entered. A stock record also goes with each order.

The shop is operated on the usual store room system, that is, the machine shop obtains its material through the stores department, manufactures it into finished parts and returns it to store from which it is drawn by the erectors. When an order to manufacture a lot of engines is given, the storekeeper separates the necessary material for these machines and places it to one side. The material so separated is designated *Applied Stores.*

To keep track of the work in the machine shop, the planning board, illustrated in Fig. 4, is used. It consists of a series of shallow steel shelves spaced about 1 inch apart. Each shelf is labeled at the left hand end with the number and name of a machine. When an order for a new lot of 100 tractors originates, a number of wooden blocks, which may be fitted in the shelves on the planning board, as indicated in Fig. 4, are made up. There is a separate block for each individual job order in connection with the manufacture of the lot of 100 machines, and all of the blocks referring to the same lot are of a distinctive color. The length of the block is proportioned to the time required to execute the job, 1 inch representing 10 hours. The blocks are disposed in the planning board by the foreman in accordance with the activity of shop operation. In this way it is possible to determine at a glance the general progress of any given lot and the amount of work ahead for each separate machine. Small, black separating blocks are used to distinguish job orders for which the necessary stock is ready beside the machine from those for which the material has not yet been obtained. The disposition of these separating blocks is indicated in Fig. 4, and all colored blocks to the left of a separating block represent jobs for which the material is ready. Therefore, when a separating block approaches near the left hand margin of the board it indicates to the foreman the necessity of getting out additional stock.

Inter-Communicating Telephone System

In connection with the planning board, an inter-communicating telephone system is being installed which will result in a considerable saving of time. With this system in operation, when a machinist completes a given job he goes to the nearest telephone and reports his machine number to the dispatcher situated in front of the planning board. The latter examines the board and reports the number on the block at the right of the one bearing the number of the job which has just been completed. The workman is thus able to immediately go ahead with his work. When a job is reported complete, the block in the planning board representing it is removed and the entire line is moved one notch to the left.

The planning board is operated in connection with a trucking system which has a number of interesting features. The truckers who carry the raw stock from the store room to the machines, and also the semi-finished material from one machine to another, are foreigners with a comparatively limited knowledge of English. They can, however, read numbers and, therefore, a guide sheet is posted outside of the foreman's cage bearing numbers and symbols, similar to the following:

2164	Store	316
2395	314	126

The first line indicates that the material for job order No. 2164 is to be obtained from the store room and delivered to machine No. 316. The second line indicates that the material for job No. 2395 must be obtained from machine No. 314 and de-

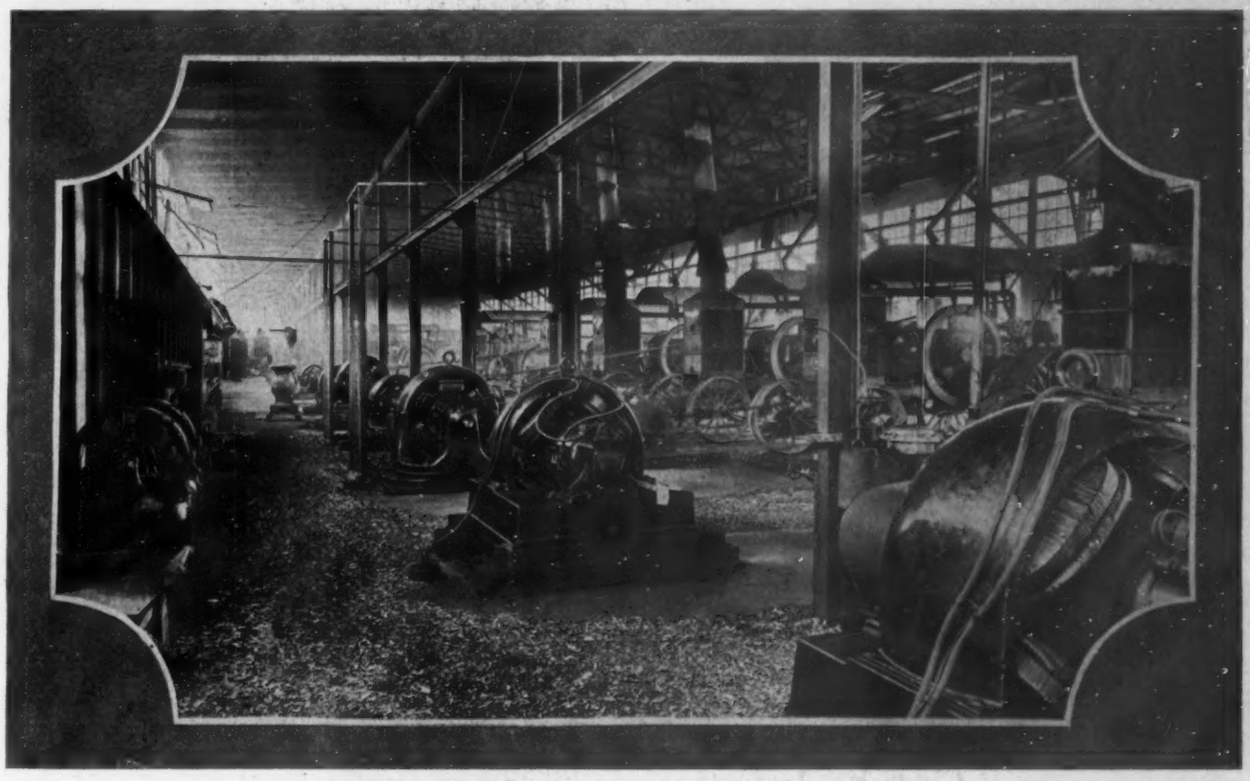


FIG. 13—THE POWER PLANT AND TESTING DEPARTMENT

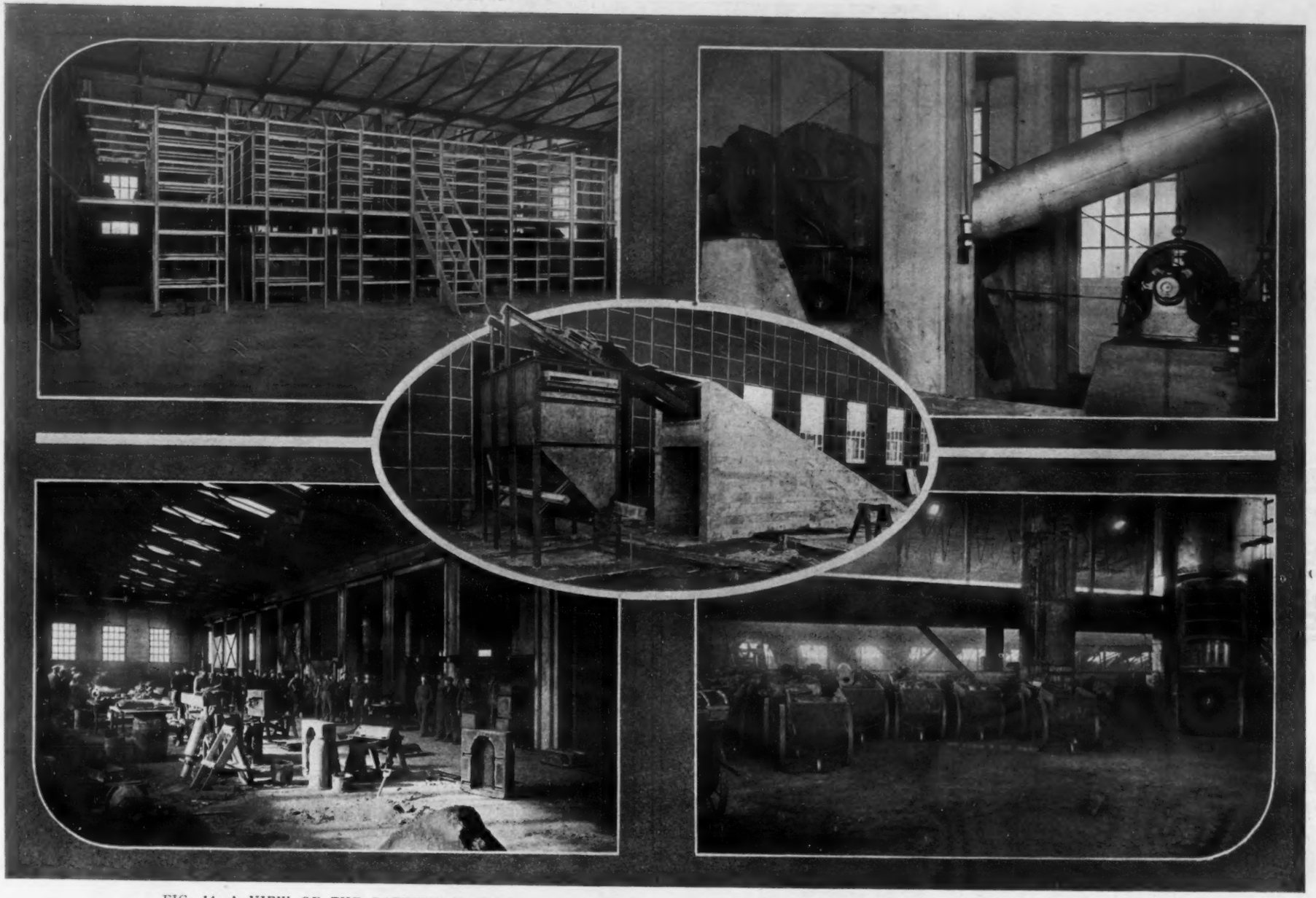


FIG. 14—A VIEW OF THE PATTERN STORAGE

FIG. 15—BLOWER ROOM IN THE GRAY IRON FOUNDRY

FIG. 16—CROSS CONVEYOR AND SAND SCREENING HOPPER

FIG. 17—CORE ROOM IN THE GRAY IRON FOUNDRY

FIG. 18—CHARGING PLATFORM IN THE GRAY IRON FOUNDRY

livered to machine No. 126. The machine numbers are posted conspicuously throughout the shop directly underneath the crane runways, as indicated in Figs. 1 and 5. In addition, a numerical directory is furnished showing the exact location of each machine. All the truckers have to do is to report to the foreman's cage and note the instructions on the guide sheet.

Tool Room Orders

In carrying out further its system of keeping an accurate record of each man's operations, the Hart-Parr Co. has adopted a novel account system for use in connection with its tool rooms. Most shops employ the usual method of furnishing each man with a number of brass checks, one of which he deposits with the tool room keeper for every tool obtained. The checks are returned to the workman when he brings back the tools or gives a satisfactory account for the material used. The Hart-Parr Co. has found this system unsatisfactory for several reasons, chief among which are that it results in a loss of time, especially when a number of men apply for tools simultaneously, and frequently creates confusion and disputes. To obviate these disadvantages, the tool account system illustrated in Fig. 27, has been installed by the McCaskey Register Co., Alliance, O. When a workman applies to the storeroom for a tool it is given to him and at the same time a record of the transaction is made on the account slip, Fig. 27. The slips are made in duplicate, the original being retained by the tool room keeper and the copy handed to the man. The original is filed and constitutes a charge against the workman. Each slip bears a consecutive number for the purpose of identification. When the tool is returned, the duplicate slip is handed in with it and the acceptance of the latter by the tool room attendant relieves the workman of his responsibility. The originals are removed from the account file when the tools are returned and are filed again, together with the duplicates returned by the workman, for future reference. In case a tool is broken the workman hands in a breakage slip, Fig. 26, signed by the foreman.

FIG. 19—MAIN BAY OF THE GRAY IRON FOUNDRY. THE SAND STORAGE BINS ARE BETWEEN THE POSTS AT THE LEFT AND THE GRATING OVER THE HOPPER FOR USED SAND IS SHOWN IN THE CENTER OF THE FLOOR

The Machine Shop

The machine shop, two views of which are illustrated in Figs. 1 and 5, is approximately 500 feet long and 100 feet wide and consists of a gabled main bay and two side bays. There is a pair of crane rails down the middle of the main bay under the apex of the monitor, thus dividing the shop into four aisles. Each aisle is equipped with ten 4,000-pound traveling hand cranes. The general arrangement of the sub-departments in the machine shop is given in the key to Fig. 23. The machine tool equipment of the shop is standard and modern. The machines are driven by individual electric motors and are so arranged that they may be moved about to meet varying conditions. Among the machine tools may be mentioned a specially built, horizontal spindle gear hobber with an upper support for the work arbor. This machine will hob teeth on gears up to 48 inches in diameter. A Pfauter gear hobber machine is also installed, together with an English bevel gear planer furnished by Hill, Clarke & Co., Chicago. In the southeast corner of the shop is a large, combined, power-driven press and punch used for shaping radiator and other sheet metal parts.

Fig. 8 illustrates a Newton double-end cylinder boring machine driven by an individual electric motor. A special jig for holding the cylinder in the machine is shown in this illustration. Fig. 6 shows the jig used for drilling the various holes in the cylinder. Special attention should be called to the inclined bed plate shown at the right of the drill in this illustration; this is in reality a part

of the jig. Fig. 7 illustrates the testing department where the cylinders are subjected to hydraulic pressure. Each cylinder is tested three times, the first time as it comes from the foundry, again after being bored and finally when finished by the machine shop. The method of heating, lighting and ventilating the shop is illustrated in Figs. 1 and 5. Flaming arc lamps are used for the general illumination and in Fig. 1 immediately over machine No. 135 may be seen one of the circular radiators equipped with a fan, which are used for heating and ventilating the shop.

Open-Hearth Steel Foundry

The steel foundry is situated immediately east of the machine shop and consists at present of a building, 250 feet long and 115 feet wide, with a small L on the north end housing the laboratories. The steel foundry equipment, which is illustrated in Figs. 9, 10 and 11, includes two 10-ton, oil-burning, basic open-hearth furnaces, a 15-ton Shepard traveling crane with a 5-ton auxiliary hoist, located in the main bay, a 5-ton Shepard crane over the charging platform and a 4,000-pound hand crane in the side bays. This shop also contains two mold drying ovens, each 25 feet long, 10 feet wide and 8 feet high inside, a sand mill and a complete oxy-acetylene welding outfit. Oil for the furnaces is stored in two sunken concrete tanks, 110,000 and 180,000 gallons capacity, respectively, together with a steel tank with a capacity of 72,000 gallons. The practice in the steel foundry is standard and presents no unusual features. One of the open-hearth furnaces is provided with a sheet steel jacket which is connected to an exhaust fan. The fan draws the hot air away from the charging floor and from the sides of the furnace and delivers it to the shop heating system in the winter and to the external air in the summer. As a result, the charging floor is cool in the summer and the shop is very economically heated in the winter.

Steel Foundry Planning Board

A planning board similar in general to that described for the machine shop is used in the steel foundry for keeping track of the work. In this department, however, instead of assigning a shelf to a machine, each shelf represents a group of flasks of a certain size and the work is proportioned by the foreman to the proper size flasks. In the steel foundry the length of the blocks used in the planning board are proportioned to the time required for the various jobs, as in the machine shop, 1 inch representing a day's work. Instead of using black spacers to distinguish job orders for which the material is ready, from the others, three kinds of spacers colored black, yellow and green are used; the black spacers are placed to indicate jobs for which the patterns are ready, the yellow spacers indicate that the flasks are ready, and green that the cores are ready. Job order blocks for which either the patterns, flasks or cores are ready are placed at the left of the respective spacers.

The Gray Iron Foundry

The new gray iron foundry is located at the extreme eastern end of the plant. The building is 207 feet in length and 308 feet in width, constructed of reinforced concrete and steel, as indicated in Fig. 25. It consists of a gabled main bay, 49 feet wide, with a 33-foot leanto on the north to which is joined a 40-foot storage platform. Joined to the south side of the main bay is another 33-foot leanto, together with five 30-foot saw-tooth bays. The main bay and first three side bays on the south are devoted to molding, giving a molding floor area of approximately 29,400 square feet. The main bay is spanned by a 48-foot, 10-ton Shepard electric traveling crane, and the side bays are provided with 2-ton hand cranes. The leanto north of the main bay is occupied by the core and mold drying ovens and includes the coremaking department. In the three saw-tooth bays south of the molding floor are the pattern storage, flask storage, tool and supply rooms, together with the cleaning department. The shop is lighted throughout by mercury vapor tubes, also there are outlets on every post for portable incandescent units. The foundry has a capacity of approximately 100 tons per day. The charging floor occupies the eastern end of the north leanto as indicated in Fig. 25. For the storage of pig iron, coke, scrap, limestone etc., a special heavily reinforced concrete platform has been built along the entire northern side of the building.

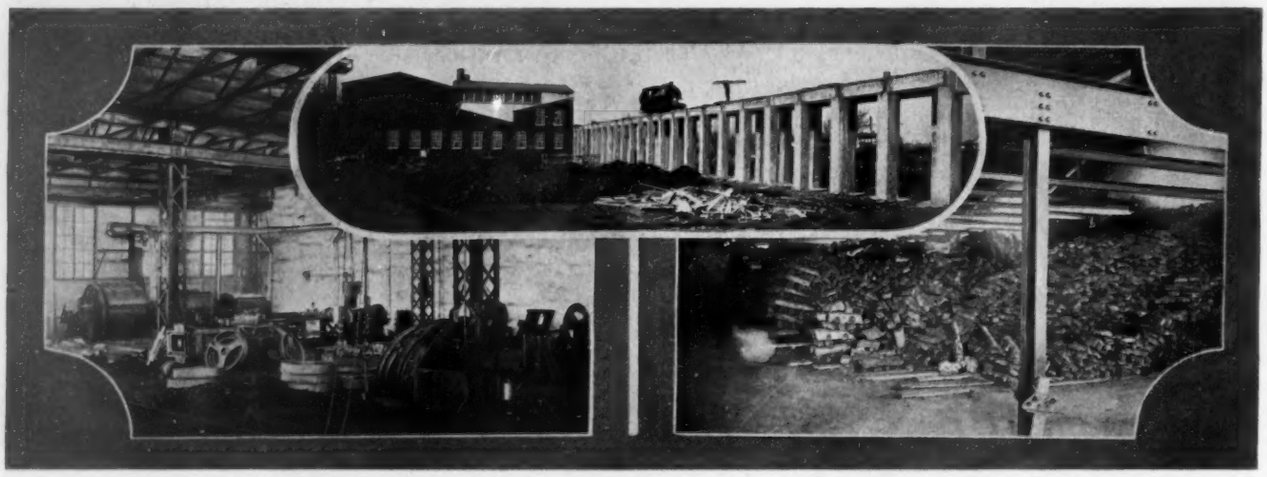


FIG. 20—GRAY IRON FOUNDRY, SHOWING CONCRETE TRESTLE LEADING TO THE STORAGE PLATFORM

FIG. 21—THE GRAY IRON FOUNDRY CLEANING DEPARTMENT

FIG. 22—GENERAL VIEW OF STORAGE PLATFORM ON CHARGING FLOOR LEVEL

Storage Platform

The construction of this platform is indicated in the cross-section, Fig. 25. It consists of an 8-inch reinforced concrete floor supported by 24-inch square concrete posts spaced 10 feet center to center. The reinforcement in the posts consists of lattice structural steel columns. There are five rows of posts under the floor; the two outer rows support the track and the dimensions of the storage shed proper are, therefore, 207 x 30

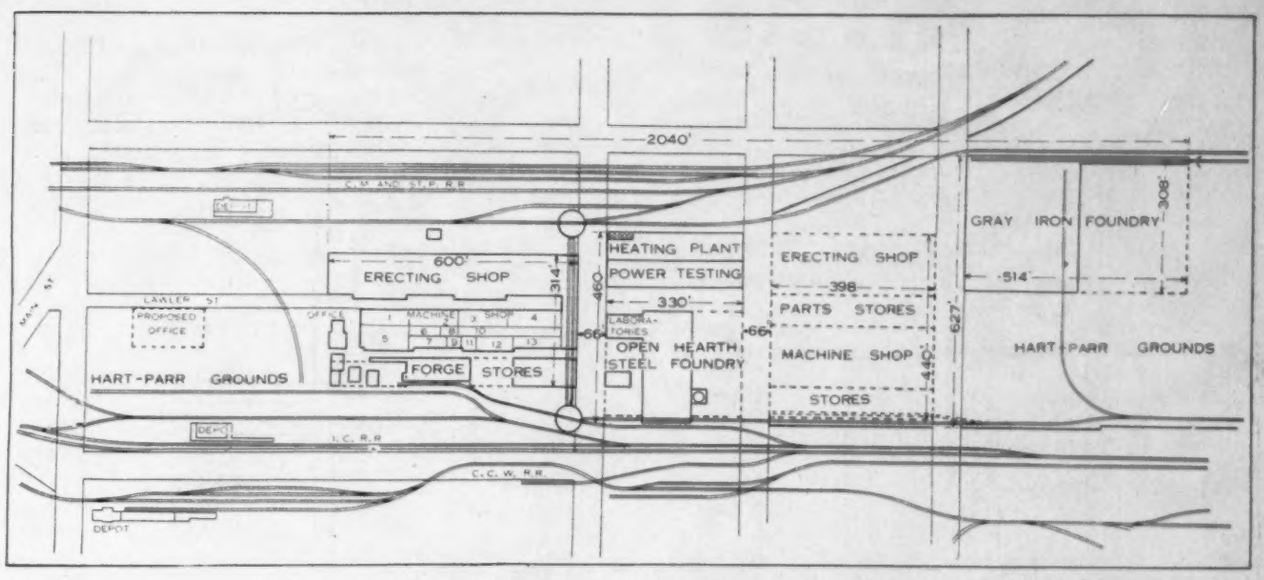


FIG. 23—PLAN VIEW OF THE HART-PARR PLANT

Sub-departments in the machine shop; 1, lathe department; 2, drill presses; 3, cylinder department, drills and boring mills; 4, crankshaft department, lathes and grinders; 5, automatic machines; 6, aisle; 7, jig storage; 8, shop office; 9, office check department; 10, gear shapers and gear hobbers; 11, check department; 12, tool room; 13, wheel department.

feet. The distance between the floor of the shed and the lower chord of the roof truss is 8 feet. The interior arrangements of the shed are shown in Fig. 22, and this illustration clearly indicates the great strength of the reinforced concrete floor. It is estimated that there is sufficient space in the storage shed to hold a four months' supply of pig iron, coke, etc. The pig iron shown in Fig. 22 includes 1,250,000 pounds of one grade alone, and back of the pig iron are 10 carloads, roughly 300 tons, of coke.

Charging Floor

The storage shed connects directly with the charging floor, Fig. 18. This illustration shows the style of buggies used for handling scrap and pig iron; a similar buggy, somewhat larger, is used for coke. The buggies are arranged so that they dump their charge directly into the furnace door. The charging floor is exceptionally roomy and is provided with the usual equipment of scales, etc. There are two cupolas, both furnished by the Whiting Foundry Equipment Co., Harvey, Ill. One is 36 and the other 66 inches in diameter inside of lining. Space is provided for a third cupola. Under the storage platform, connecting directly with the main floor of the foundry, is space

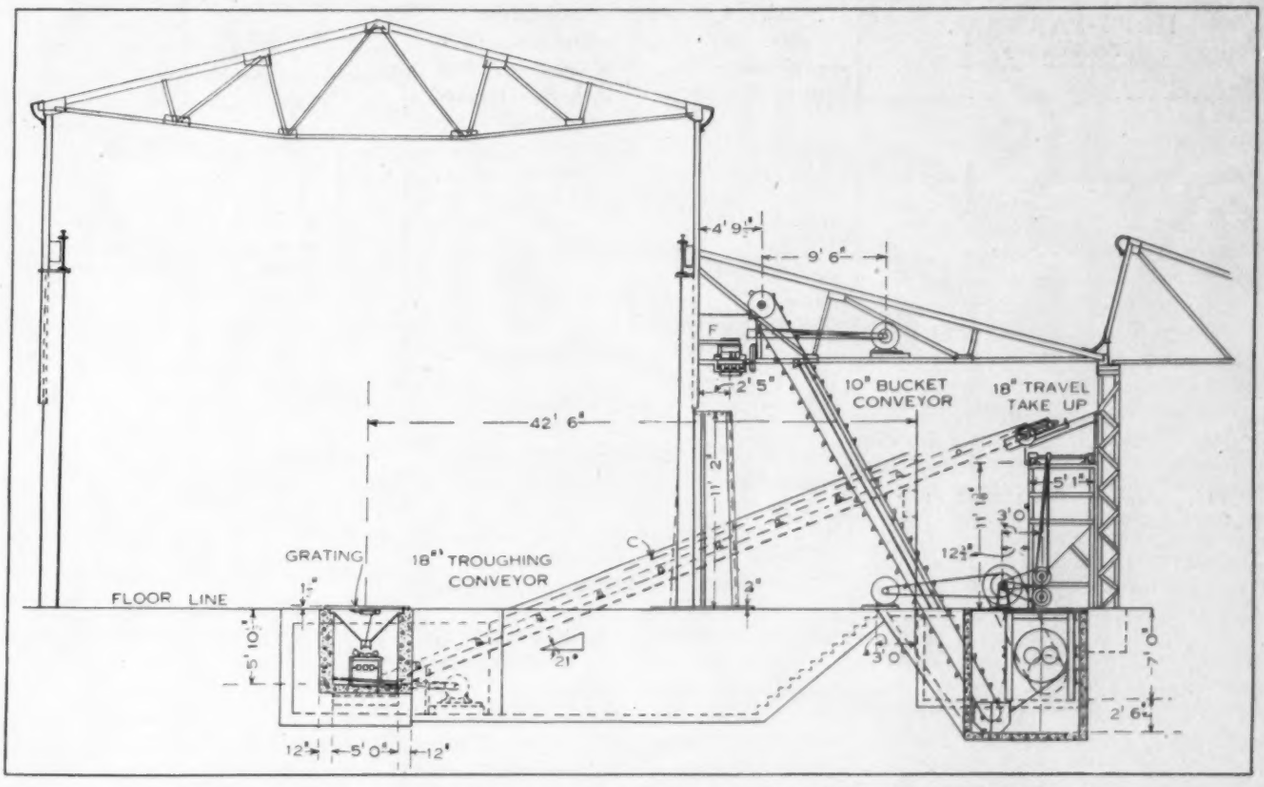


FIG. 24—ELEVATION OF SAND HANDLING MACHINERY IN THE GRAY IRON FOUNDRY

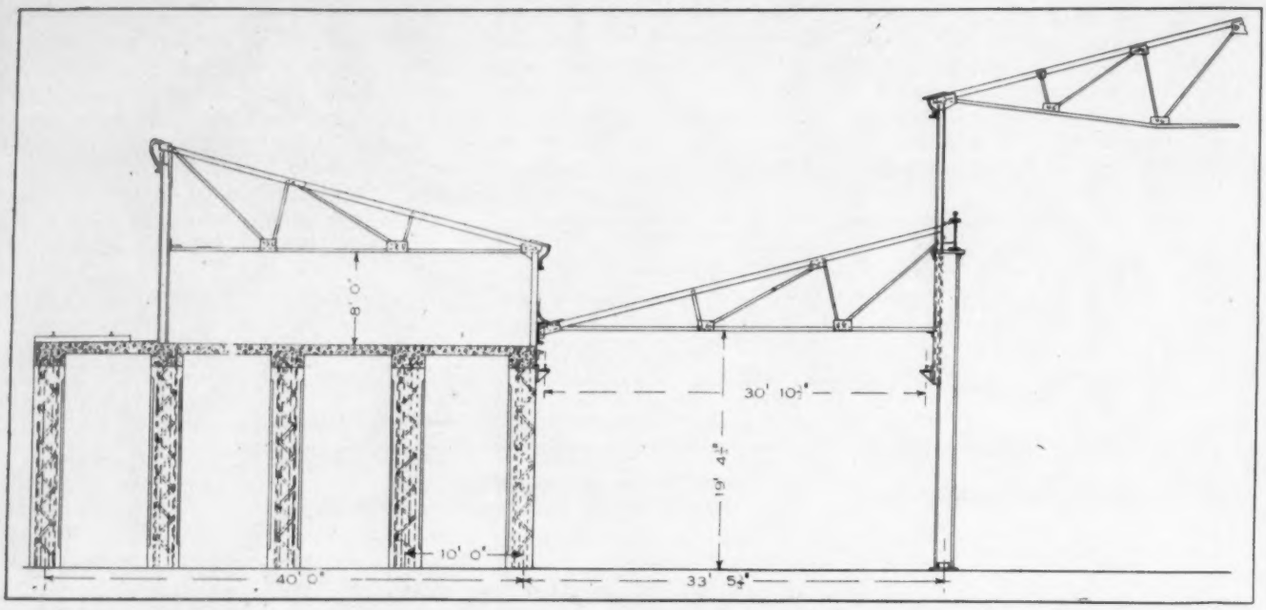


FIG. 25—CROSS-SECTION OF THE NORTH HALF OF THE GRAY IRON FOUNDRY, SHOWING CONSTRUCTION OF THE CHARGING PLATFORM

for the storage of core sand, oven coke, etc. Chutes which are located in the floor at convenient intervals alongside the track permit this material to be unloaded directly from the cars.

The general arrangement of a portion of the main floor, devoted to coremaking and containing the core and mold drying ovens, is shown in Fig. 17. The equipment in this department is standard in every respect. The core ovens are square and are each placed between four of the concrete posts that support the storage floor above. The ovens, therefore, have four sets of drawers opening on each side with but one fire box and chimney. The four mold drying ovens, each 20 feet long, 6 feet wide and 6 feet high inside, are equipped with cars running on ball tracks.

HART-PARR CO.
Breakage Slip

Date _____ TOOL CHECKER

Check Dept: Replace _____

Name of Tool _____
Broken by _____ No.
NAME OF WORKMAN

Caused by _____

Foreman _____

Remarks _____

TOOL DEPARTMENT

FIG. 26—TOOL BREAKAGE SLIP

The principal features of the sand-handling equipment are illustrated in Fig. 24. It consists of a 5-foot grating, which extends the full length of the main bay under the main traveling crane and beneath which is a continuous steel bin provided with gates at the bottom discharging into an 18-inch troughing belt conveyor. This conveyor discharges the sand onto an 18-inch inclined cross conveyor, *C*, Fig. 24, leading to the screening hopper. The latter conveyor is approximately 50 feet in length and is equipped with an 18-inch travel take-up at the upper end. The angle of this conveyor is 20 degrees. It is equipped with a magnetic head pulley, which prevents any particles of iron from being discharged into the screening hopper. The latter is approximately 10 feet long, 5 feet wide and extends 11 feet above the ground. The general arrangement of the cross conveyor and screening hopper is shown in Fig. 16.

From the screening hopper the sand is carried in a screw conveyor to a large rotary sand-mixing and tempering machine furnished by the Standard Sand & Machine Co., Cleveland. This machine is located in a pit in front of the screening hopper.

The mixing machine drops the prepared sand into the boot of a 10-inch bucket conveyor which carries it up to the 18-inch flat conveyor, *F*, Fig. 24, extending over the molding floor. The latter operates the full length of the shop and deposits the sand in the five bins, *B*, Fig. 19, from which it is drawn for use. Diagonal sweeps are used to divert the sand from the belt to the bins. The bins are constructed of reinforced concrete and are each 11 feet high and 15 feet long, tapering from 3 feet wide at the top to 4 feet at the bottom.

A corner in the cleaning room is shown in Fig. 21. This department is equipped with three tumblers ranging from 36 to 62 inches in diameter, together with the usual array of grinders, chipping hammers, etc. All parts of the cleaning room floor are served by a series of 2-ton traveling hand cranes. Also for shipping heavy castings, a standard gage track ex-

Form S D-32.
HART-PARR CO.
Tool Account of No. _____

NOTICE TO WORKMEN.

This account MUST NOT BE DESTROYED. When Tools are returned THIS SLIP must go with them, and no changes are to be made hereon except by Check Department Employees.

(NOTICE ON REVERSE SIDE)

33002

FIG. 27—TOOL ACCOUNT SLIP

tends into this department. Adjacent to the cleaning department is a large room used for flask storage. It is well lighted, heated and equipped with three 4,000-pound capacity traveling hand cranes. The flasks are stored in numbered rows so that they may be easily located. Another room similar to the flask storage room is used for the storage of small tools and miscellaneous minor supplies.

Pattern Storage

The arrangement of the pattern storage is indicated in Fig. 14. This room is absolutely fireproof, the construction of the walls and roof being entirely steel and concrete. The shelves consist of 2-inch reinforced concrete slabs supported by a framing of steel angle bars. The shelves are numbered and the customary provisions are made so that any pattern which may be required can be located without trouble. The foundry keeps an elaborate record of every individual pattern in the form indicated in Fig. 29. This form is made up in sheets, 8½ x 13 inches, arranged for insertion in a loose-leaf book. The record includes the name of the pattern together with the various identification numbers and a complete schedule of the loose pieces. This record also indicates the number and location of the core boxes used in connection with the pattern and, in addition, such follow boards and flasks as may be specially required for use with this particular pattern. The record is signed by the entry clerk so that the responsibility for its correctness may be determined.

HART-PARR CO.

Form No. D 2 Date

PATTERN RECORD.

Name ..... Part No. .....
Supercedes No. ..... Name .....
Superceded By No. ..... Name .....
Pattern is for ..... Casting
To be used for .....
Pattern is to be made of ..... Except .....
Allow for ..... Shrinkage
This pattern order is for { New Pattern / Change in old pattern number .....
Further Remarks .....

Ordered By ..... Date .....
To be made in ..... Dept. to be finished by .....

PATTERN SHOP REPORT.

Record must be made below of each loose piece to Pattern and each loose piece must have part number and letter number.

The following pieces for Pattern No. ..... were made and delivered to ..... Foundry
By ..... Date .....
Loose Piece No. ..... Letter No. ..... Name ..... Made of .....
Loose Piece No. ..... Letter No. ..... Name ..... Made of .....
Loose Piece No. ..... Letter No. ..... Name ..... Made of .....
Pattern Checked by ..... Date .....
Above Pattern and Parts were Received
By ..... Foundry. By ..... Date .....
Same are stored as follows:
Pattern No. ..... Section No. ..... Rack No. ..... Shelf No. .....
Pieces No. .....
Are stored in Section ..... Rack No. ..... Shelf No. .....
Core Box No. ..... Stored in Sec. Rack No. ..... Shelf No. .....
Follow Board No. ..... Stored in Stall No. .....
Flask No. Z. { Drag No. Z ..... Letter No. ..... / Core No. Z ..... Letter No. ..... / Check No. Z ..... Letter No. ..... / Check No. Z ..... Letter No. } In Stall No. .....
Match Board No. Z .....
Match Board No. Z .....
Record was made in ..... Foundry Record Book By ..... Date .....
Record was made in Drafting Room Books By ..... Date .....
Further Remarks .....

FIG. 29—PATTERN RECORD BLANK

Fig. 2 shows the center aisle of the erecting shop which is 600 feet long and 100 feet wide. It is constructed of concrete and steel, uniform with the other buildings, and is located parallel to and immediately north of the machine shop. The main bay is served by a heavy traveling crane, which is used to transport tractors after they are erected. The side bays in the erecting shop are served by 15 small traveling hand cranes. As previously stated, the manufactured parts are delivered to the custody of the storekeeper by the machine shop and are obtained from him by the erecting department on proper orders from the production department. The machines are erected under the supervision of the erecting foreman.

NAME OF WORKMAN ..... DEPT. .....

ENGINE NUMBER	OPERATION	SIZE OF ENG.	DATE WEEK END'G	ACTUAL JOB TIME	EARNED HOURLY RATE	ST'D. COST OF LABOR	WAGE RATE	JOB COST	PER-JOB LOSS	PER-JOB GAIN	TOTAL LOSS	TOTAL GAIN
4694	Engine	60HP	9-14-12	46 Hrs.	.286	13.20	.29	13.34	14		14	
4681	"	"	9-14-12	46 "	.286	13.20	.29	13.34	14		28	
4702	"	"	9-21-12	38 "	.347	13.20	.29	11.02		2 18		1 90
4716	"	40HP	10-5-12	66 "	.166	11.00	.29	19.14	8 14		6 24	
4823	"	60 "	10-12-12	38 "	.347	13.20	.29	11.02		2 18	4 06	
4851	"	"	10-26-12	31 "	.425	13.20	.30	9.30		3 90	16	
4837	"	"	10-26-12	37¾ "	40 "	13.20	.30	9.82		3 38		3 22
												3 22
4861	"	"	11-2-12	30¾ "	43 "	13.20	.30	9.22		3 98		7 20

FIG. 28—WORKMAN'S ACCOUNT CARD, SHOWING LOSS OR GAIN COMPARED WITH STANDARD CONDITIONS

Testing Plant

A unique feature of the Hart-Parr plant is the power and testing department, Fig. 13. This building, which is 325 feet long and 64 feet wide, is located immediately north of the steel foundry. It contains ten 42 to 50-kilowatt direct current generators

arranged as indicated in Fig. 13. These generators are belted to the finished tractors undergoing test. Each machine, before being shipped, is tested with an electric load from 20 to 40 hours. The unique feature of this arrangement is that the power generated in this manner is used for the operation of machines throughout the plant, and no other power generating capacity is employed. It may be stated, therefore, that the shop is literally operated by its own product.

The Hart-Parr Co. is giving the attention to welfare work demanded by progressive management. A mutual relief association has been organized, which provides benefits to disabled employes in case of accident. Also special attention to safety appliances is a part of the daily routine of every foreman and department manager.

United States By-Product Coke Development

By C W Andrews

THE first by-product coke plant in the United States, consisting of 12 ovens, was placed in operation at Syracuse, N. Y., in 1893. This installation was followed by one at Johnstown, Pa., in 1895; one at Dunbar, Pa., 1896, and one at Glassport, Pa., 1897. The Syracuse plant was primarily intended to supply the owners with ammonia for their alkali works. At Glassport, gas was sold for illuminating purposes for the first time, although it was mixed with water gas to make it marketable. The New England Coke & Gas Co., in Boston, in 1899, started the plant which changed the whole trend of the establishment of by-product plants, since for the first time it manufactured illuminating gas, suitable for sale without enrichment. This was accomplished by dividing the gas on the battery into two portions. One portion, the richer part of the gas, was saved for sale, while the leaner portion was used in the battery. This idea originated with Dr. Schniewind, of the United Coke & Gas Co. The coke was used for domestic, industrial and locomotive fuel, as its sulphur content was too high for foundry use. The successful operation of this plant led to the construction of others at points where illuminating gas was sold advantageously and where there was a fair market for the coke. The following illuminating gas plants, in order of construction, give a good idea of the rapid growth of this method of combined gas and coke manufacture: Hamilton, O.; Detroit; Camden, N. J.; Baltimore; Chester, Pa.; Milwaukee; Duluth, Minn.; Geneva, N. Y.; Chicago and Indianapolis. In addition plants are now under construction at Muncie, Ind.; Joliet, Ill., and Waukegan, Ill., which will produce illuminating gas and metallurgical coke.

Plants also have been built at the following points of pig iron or steel construction: Birmingham district; Benwood, W. Va.; South Sharon, Pa.; Buffalo; Lebanon, Pa.; Steelton, Pa.; Cleveland; Joliet, Ill.; Gary, Ind., and plants at Bethlehem, Pa., and Mayville, Wis., are under construction. This shows that, with few exceptions, the steel plants and blast furnaces outside of the coking coal district receive nearly their whole coke supply from by-product ovens, a decided change from 15 years ago, when Cambria was practically alone in the field.

The question is frequently asked why by-product ovens are not being built more freely in the central coking districts. I think that the following statistics fully answer this question. In 1907, the total production of coke in the United States was 40,780,000 tons, of which 5,608,000 tons were produced in by-product ovens and 35,172,000 tons in beehive ovens. During the year ended 1910, the largest year in the history of the business, the total production was 41,709,000, of which 7,139,000 were by-product and 34,570,000 were from beehive ovens. This shows an actual decrease of 600,000 compared with three years previous. The beehive production made an even poorer showing in 1911, as out of 35,550,000 tons, 7,848,000 tons were by-product and 27,707,000 were from beehive ovens. Since a large proportion of the total of beehive coke is produced in the central coking district, it is evident that the present beehive ovens are ample to care for the demand during ordinary years. Consequently, if by-product plants were built by the present operators, the result would be a loss of the large investment in beehive ovens necessary for the corresponding output. In addition, the operators would practically be unable to sell profitably the gas for illuminating purposes because of the competition of natural gas. There is no doubt that the gradual exhaustion of the coal and gas fields will lead eventually to by-product ovens throughout the district, since the decrease of about 10 per cent in yield obtained with by-product ovens, and a market for illuminating gas, will eventually become of sufficient importance to justify the move.

The completion of the plant of the Lehigh Coke Co., near Bethlehem, and of the Minnesota Steel Co., at Duluth, together with others in prospect, will soon make most of the steel plants outside of the Pittsburgh district self-contained, so far as the coke supply is concerned. The by-product ovens will probably take the place of natural gas in many cities in the central states when the natural gas supply begins to fail. The use of producer gas to heat ovens was suggested by Dr. Schniewind, in 1898, but its use was not extended for various reasons. Within the last two or three years, however, conditions at certain points have favored more this form of gas production and several systems have been devised whereby combination ovens are constructed. The latter are designed so that either producer gas or lean oven gas can be used for heating the brick work. In this way, the ovens can care for the summer consumption under most favorable conditions and a producer gas plant can handle the increase in the winter consumption.

The final result of by-product oven construction, apparently, will be its gradual spread of coke manufacture over practically the whole country instead of in the coking-coal district. This would result in the conservation of our coking-coal supplies, as not only is a larger yield obtained, but it is also feasible to use coals which are not ordinarily suitable for coking in beehive ovens. The saving of residuals, such as tar, ammonia and illuminating gas is also of commercial importance, since before long large quantities of ammonia sulphate will be used in the United States in the manufacture of fertilizers, creosote oil for wood-preservation and pitch for briquetting certain grades of coal.

[1]Presented at the Cleveland meeting of the American Institute of Mining Engineers, October, 1912

THE ABC OF IRON AND STEEL

Pig Iron and Its Method of Manufacture

By John Jermain Porter

THE modern blast furnace is not only the most tremendous and spectacular of machines, but it also is representative of the most important of all manufacturing industries. It is, perhaps, not generally appreciated that our annual output of pig iron has a greater value than any other single manufactured product, and greater, also, than all other metals combined. In addition, it forms the raw material for all finished forms of iron and steel and is the basis for such diverse articles as frying pans and sky-scrapers, cook stoves and locomotives.

Iron ore, the raw material of the blast furnaces, is an oxide of iron usually more or less contaminated by various impurities, and it is the function of the blast furnace to remove the oxygen from the iron and to slag-off the impurities. Carbon in the form of coke is the usual deoxidizing agent and its combustion also furnishes the heat necessary to melt the resulting iron and slag. Limestone is added as a flux to render the slag more easily fusible.

The following articles of this series previously have been published in THE IRON TRADE REVIEW: "Iron Ore and Mining Operations," Jan. 5; "Beneficiating Iron Ores," Feb. 2; "Rules for Figuring Penalties and Premiums on Lake Superior Iron Ores," March 9; "Transportation of Iron Ore on the Great Lakes," March 16 and April 13; "Ore-Handling at Lower Lake Ports," Oct. 12, 1911; "The Manufacture of Bee-Hive Coke," Jan. 4, 1912.

For the photographs, from which the engravings, Figs. 1, 2, 3, 4, 9 and 10, were made, we are indebted to W. B. Pollock & Co., Youngstown, O.

John Jermain Porter

John Jermain Porter, consulting metallurgical engineer, Staunton, Va., was a student at the University of Cincinnati from 1898 to 1901. After a brief experience in western mining districts, he was employed as a chemist at the Shenandoah, Va., furnace of the Oriskany Ore & Iron Co. Subsequently he was employed in a similar capacity at blast furnace plants at Buena Vista, Va., and at Dubois, Pa. In 1905 he was employed by the Illinois Steel Co. as blast furnace foreman and later became furnace superintendent at Iron Gate, Va. From 1906 to 1907, Mr. Porter was assistant to Charles Catlett, consulting geologist of Staunton, Va., and in 1907 he was appointed associate professor of metallurgy at the University of Cincinnati, which position he recently resigned. Mr. Porter has contributed liberally to the proceedings of technical societies on subjects of blast furnace and foundry practice.

The chief reactions which take place in the blast furnace are indicated in Fig. 11, which shows the sequence of change in the solid materials as they descend from top to bottom of the furnace. It should be understood that the furnace always is kept filled with these materials. As the coke, ore and limestone are burned and melted away in the hearth, the column above settles and fresh quantities are charged into the top to maintain the supply.

As the molten iron and slag run down into the hearth, they separate, owing to the difference in their specific gravities, the lighter slag floating on the heavier iron. Two tap holes are provided at different levels. From the lower of these the iron runs into a series of channels which guide it into either pig beds or receiving ladle, while from the upper tap hole the slag is tapped into a slag ladle or into a tank of water known as a granulating pit.

The air necessary for the combustion of the coke is forced into the furnace under a pressure of 8 to 16 pounds per square inch, by powerful blowing engines. Before passing into the furnace, however, it is first forced through hot blast stoves, where it is heated to a temperature of from 700 to 1,400 degrees Fahr. This temperature being added to the heat of combustion of the coke, adds greatly to the smelting power and decreases the fuel consumption.

The gases resulting from the combustion of the coke are partially combustible and have a considerable fuel value. They are, therefore, drawn off from the top of the furnace, more or less perfectly cleaned and then burned, partly under

the boilers to raise steam and partly in the hot blast stoves to heat the blast. Owing to this use of what were formerly waste gases, it is now very seldom necessary to use any large amount of coal at a modern furnace plant.

The quantity of materials handled at a modern blast furnace is very impressive. Such a plant will have to be fed every 24 hours with some 800 tons of ore, 400 tons of coke and 100 tons of limestone or a total of about 1,300 tons of solid materials. In addition, about 2,500 tons of air must be pumped into it. About 400 tons of pig iron will be produced in this same period of time. It is evident from this that even a single unit plant means a large production, necessitating large working capital and producing a freight traffic equal to that enjoyed by many small railroads.

The blast furnace has not always been run on so tremendous a scale, but on the contrary, the development has been very rapid within recent years. Sixty years ago, the average furnace was a small affair built of stone masonry, about 20 feet high, and having a daily output of about 5 tons. The modern blast furnace is a 90-foot giant, built of steel and firebrick, and has a daily output of from 400 to 500 tons. Coincident with this development the output of pig iron in the United States has increased from about 700,000 tons to approximately 30,000,000 tons per annum.

The blast furnace is supposed to have originated in the Rhine provinces about the beginning of the fourteenth century, but for the first three centuries of its existence very little progress was made except as regards its introduction into other countries. The first great improvement in the process was the substitution of coke for charcoal as fuel. Experiments along this line were begun as early as 1620, but the use of the new fuel did not become general until about 1750.

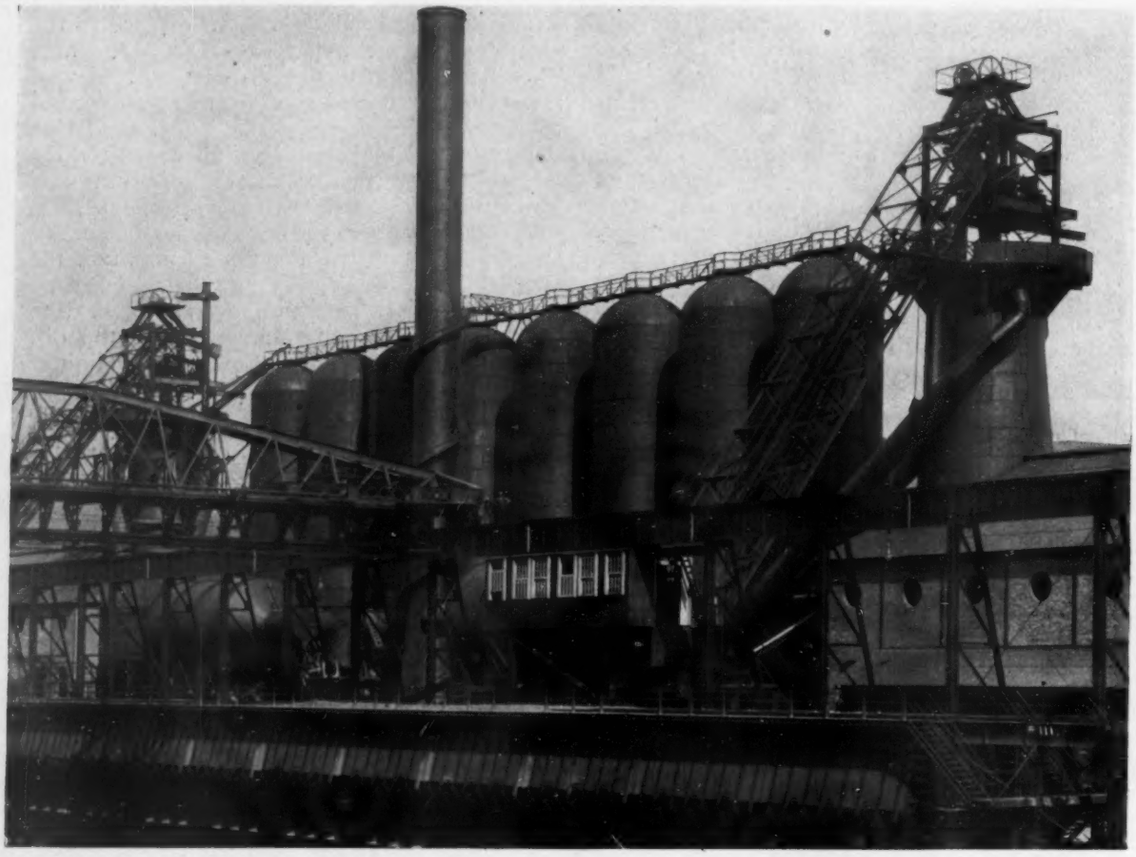


FIG. 1—MODERN BLAST FURNACE PLANT, CONSISTING OF TWO STACKS, SHOWING THE TRAVELING ORE BRIDGE AND ORE POCKETS

In 1829 the most important single improvement ever made in blast furnace practice was brought about when Neilson introduced the use of hot blast at certain Scotch furnaces. Previous to this time, the average fuel consumption had been about 5 tons per ton of iron made. The heating of the blast to a temperature of 600 degrees Fahr. reduced this at one stroke to 2 tons or less, and at the same time made possible a greatly increased output.

The original method of heating the blast was by forcing the air through pipes which were set in a suitable furnace and externally heated by a coal fire. The next step was to place these heating pipes on top of the furnace where they could be heated by the waste gases. Finally, the closed top was introduced, the blast furnace gases being brought down by flues and used not only to heat the gas, but also burned under the boilers for the purpose of raising steam.

About this same time, a considerable advance was made along the whole line of furnace construction, the size being greatly increased while a sheet steel jacket and fire-brick lining replaced the old masonry construction. Regenerative hot blast stoves of substantially the same form as used at present were also introduced about this time.

It is noteworthy that up to 1880 most of the great improvements introduced in the manufacture of iron had originated in England, this being the natural result of England's pre-eminence in the industry. America had lagged far behind. The industry which had been originally established near Jamestown, Va., in 1620, had for many years made very slow progress. In 1840, it was discovered that anthracite coal could be used as fuel in place of charcoal. This acted as a stimulant, but it was not until after the close of the Civil War that really rapid progress was made.

In the decade, 1880-90, particularly good progress was made in this country. The state of technical excellence reached in England was overtaken and surpassed, and coincident with this our production increased to such a point that England was deposed from her leading position in the industry. During the past 20 years our country has retained the leading place in the manufacture of iron, both as to production and in the improvement of its technology. The first distinctively American improvement came in the use of more powerful blowing engines and the greatly increased production due to more rapid driving. The pioneer in this movement was James Gayley, and as a result, partly of his work and partly of the introduction of the rich Lake Superior ores, the average output of our blast furnaces between 1880 and 1890 increased from about 75 tons to approximately 200 tons per day.

Of the last 20 years of progress, the first 10 were chiefly marked by larger furnaces,

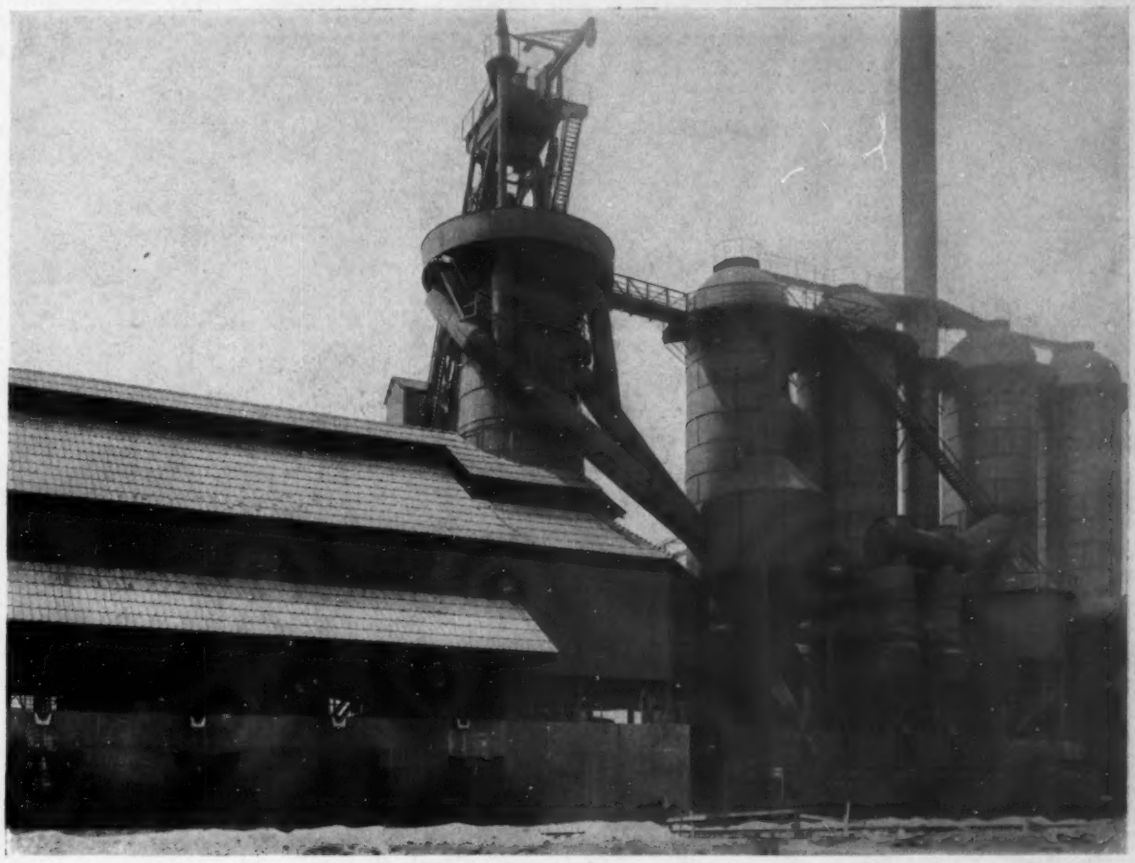


FIG. 2—METHOD OF CASTING IRON DIRECT INTO LADLES, THESE VESSELS BEING DISPOSED ON A TRACK OUTSIDE OF THE CAST HOUSE

better engineering construction and greatly increased output. Furnaces, as high as 106 feet, having an output of about 600 tons per day, were built and operated sucessfully. Methods for the mechanical handling of the ore, fuel and pig iron on an unprecedented scale were developed and output was made the first consideration.

The last 10 years of progress have been marked by greater attention given to economy of production and less to output. It has been found that the best results as to fuel consumption are obtained with furnaces about 90 feet high, and the very high furnaces of the preceding decade have been cut down accordingly. Much greater attention has been given to the details of the preparation and charging of the raw materials, and it is not usually considered desirable to force a furnace to produce much beyond 400 tons per day.

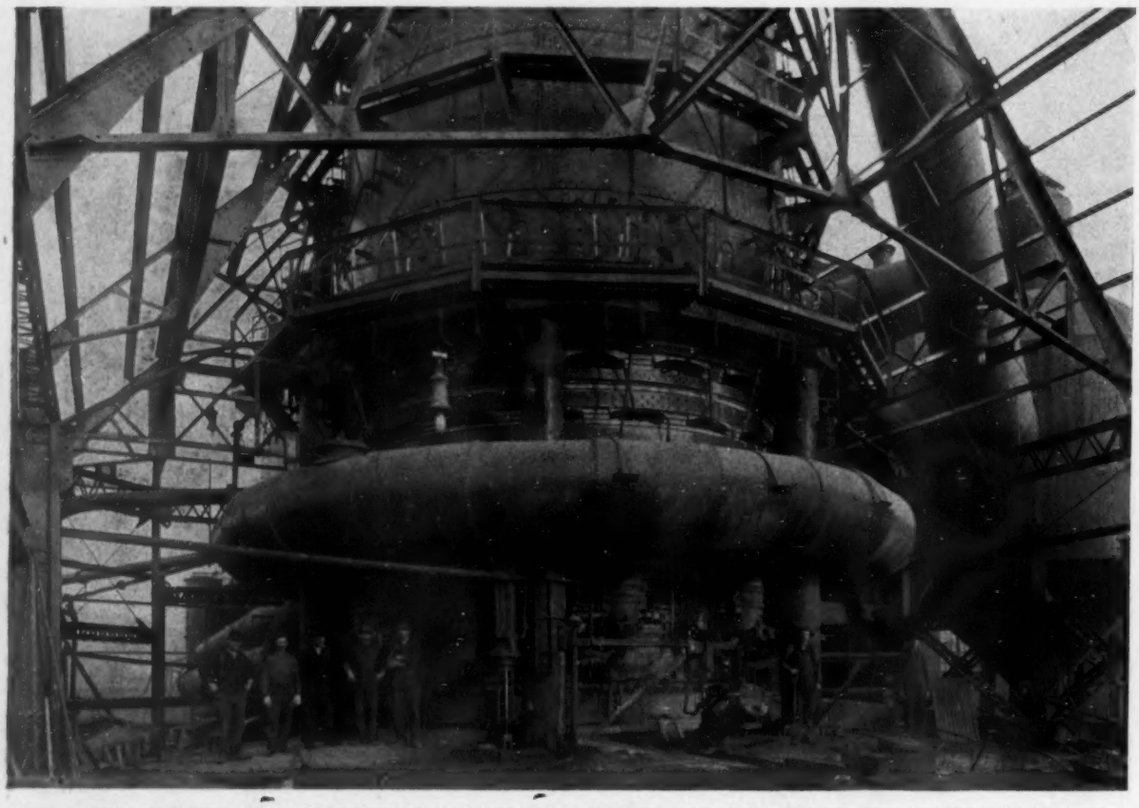


FIG. 3—THE HEARTH OF A MODERN BLAST FURNACE, WHICH CLEARLY SHOWS THE DISTRIBUTION OF THE TUYERES

The past decade will also pass into metallurgical history as having produced the greatest single improvement since the invention of the hot blast. I refer to the introduction of James Gayley's dry blast process, an invention which has decreased fuel consumption by 20 per cent and has increased output in the same ratio. This process has for its principle the freezing of the moisture out of the air before it is pumped into the furnace, thus greatly increasing the heat produced in the smelting zone and enabling the use of a smaller percentage of fuel. The results of this drying of the air are so remarkable that they were at first received with incredulity, especially abroad, but the process is now being rapidly adopted by many of the leading interests on both sides of the Atlantic and will soon, no doubt, become as universally used as Neilson's hot blast.

The management of a blast furnace differs from that of most other industries in that what is required is not only genius for organization, ability to handle men and an understanding of machinery, but, more important than any of these, a profound insight into a very complex metallurgical process. This fact has been generally recognized and the old-time furnaceman has been largely succeeded by the man who has received a technical education, supplemented, of course, by practical experience in the works. In line with the tendency in other industries, there has also been a change from the old-time rule-of-thumb plan of running a furnace to the modern exact method where everything is carefully weighed and all charges are mixed in accordance with calculations based

on chemical analysis. As showing the necessity of chemical analysis of the raw materials and accurate calculation of the charges, we may cite the case of the slag, which, if too silicious or acid, will cause the pig iron to be of such poor quality as to be unsalable, while if it be too limey, or basic, it will be infusible and will refuse to run from the bottom of the furnace.

In this connection the writer recalls the case of a furnace manager who substituted for a certain ore, another containing an equal amount of silica but less alumina. The alumina had not been determined by the laboratory and hence this difference was ignored in the calculations. At the same time, it so happened that there were heavy rains and the ore arrived at the furnace in a very wet condition. The limestone was also wet, but being lumpy it absorbed and retained much less water. The consequence of the combined effect of these two disturbing elements was that the proportion of limestone to ore was so increased that the slag became too basic to be readily fusible. It required two days to melt out the hearth and get the furnace to working properly again, and the cost of this experience to the owners of the furnace was in the neighborhood of $2,000.

One of the most important features in connection with the operation of a furnace is correct charging of the raw material into its top, as any irregularity here will very quickly make itself felt in the quality of the product and as an increase in the quantity of fuel required. The cause of this is that irregular distribution invariably means more or less segregation of the lump and fine material. Since the fine packs more closely and offers more resistance to the passage of the gases, this in turn means that there will be channeling of the gases, or they will pass up one side of the furnace, rather than the other. As a result, part of the ore reaches the bottom of the furnace in a very poorly prepared state, thus increasing enormously the work to be done in the hearth. Almost every furnace manager has at some time in his career traced a period of trouble and bad furnace work to some lazy top filler who would dump all the materials being charged into that side of the furnace hopper nearest to the elevator. Within recent years, far more serious difficulties have arisen through the imperfect distribution given by some of the mechanical filling devices. The sequence of events in these cases was about as follows:

The materials, in being hauled up the inclined hoist track, were more or less jolted and hence the fine particle settled, at least

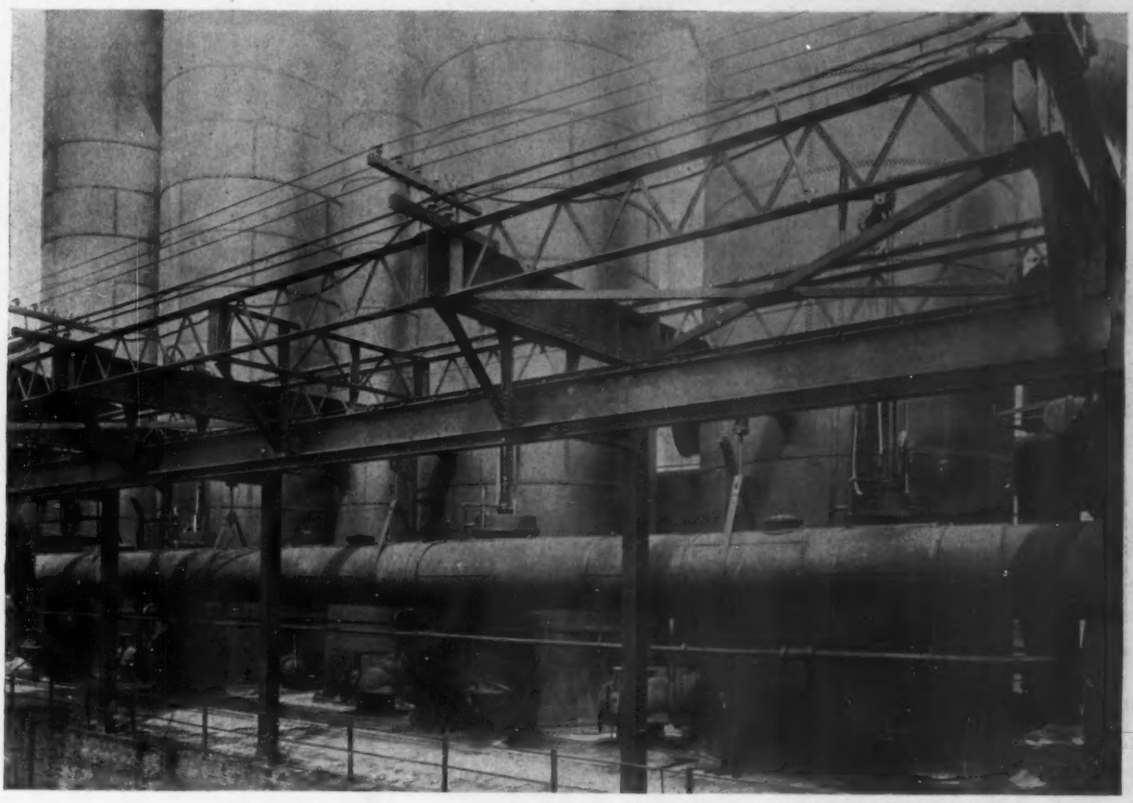


FIG. 4—HOT BLAST STOVES, SHOWING THE VALVES FOR CONTROLLING THE BLAST

partially, to the bottom of the skip bucket. When the skip bucket was dumped into the furnace hopper, the lumps were thrown to the far side of the hopper while the fine material fell out on the near side just under the nose of the skip. The fine and lump, being now segregated onto opposite sides of the hopper, were dumped into opposite sides of the furnace, and the channeling of the blast through the side containing the lump material soon resulted in the cutting of the lining at that point and the production of a hot spot plainly evident from an outside inspection. About this time it generally became necessary to blow out and reline the furnace.

It was a number of years before these troubles were traced to their origin, but when the seat of the difficulty was recognized, blast furnace engineers promptly arose to the occasion and several forms of rotary distributers were devised which are at the present time giving excellent satisfaction.

This brings up the general topic of the ills of the blast furnace, a subject not without interest to the layman since this giant when sick is apt to carry on some queer performances and afford more or less excitement.

One of the most common ills is the condition known as scaffolding, which means that the material within the blast furnace instead of descending uniformly adheres to one side and builds out as a pasty mass. Occasionally, parts of this scaffold break off and fall to the hearth, thereby deranging the working and damaging the quality of the product. The disorder comes from various causes, but most usually, perhaps, from poor distribution. The effects on the quality of the product and the fuel economy are very serious, and a satisfactory cure is rarely accomplished since, even though the scaffold may be dislodged, it will have a strong tendency to build out again and become as bad as before.

A slip in a blast furnace is a term used to describe the sudden settling of the stock through a considerable distance accompanied by a more or less violent puff of gas at the top. Slips have their origin in the bridging over of the stock at some point well down in the furnace shaft, forming a partial obstruction to the passage of the gas and causing an increase in the gas pressure in the lower part of the furnace. This bridging is sometimes, though not always, due to the building out of a scaffold. As smelting proceeds in the hearth, a cavity is formed below the bridged portion and when the arch finally breaks, the materials above it fall into this cavity, producing the slip.

At the same time, the relief of the high pressure gas converts the furnace for the instant into a sort of air-gun and more or less solid material is apt to be carried from

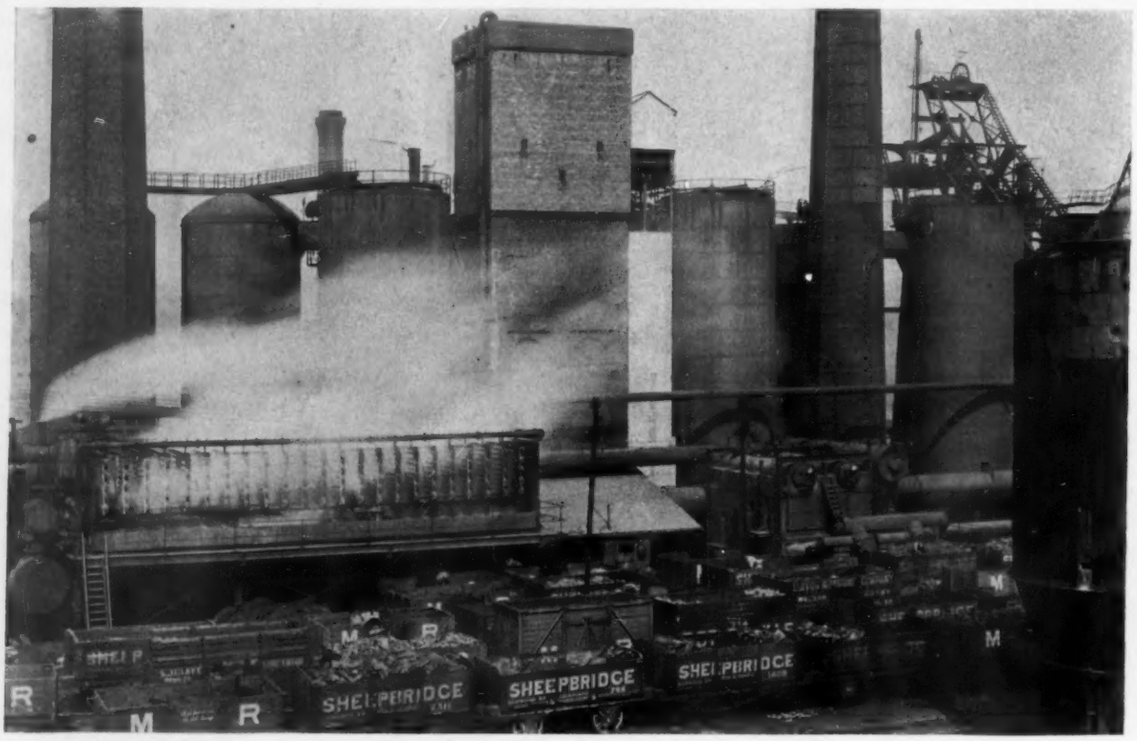


FIG. 5—A LARGE ENGLISH BLAST FURNACE PLANT

the top of the furnace by the rush of gases. The ejection of this material by the action of the gas has been compared to the foaming of champagne when the cork is drawn from the bottle.

The great majority of these slips are not serious in their consequences, as they carry out only a little dust, but in some cases they are so violent as to throw out large amounts of lump ore, coke, etc. Most furnaces subject to these heavy slips are provided with so-called explosion doors, which are really safety valves arranged to open under excessive gas pressure. As showing their severity in some cases, the writer has seen a half pig accompanied by over a carload of coke thrown out of these doors. The pig, by the way, came down through the office building, but did no permanent harm other than the wrecking of a few nervous systems.

A slip is to be regarded more as a symptom than as a disease, but the condition which produces slips will sometimes culminate in what is probably the most serious of all ailments, a freeze-up of the hearth. When this condition is reached, the iron and slag in the hearth have set to a solid mass which renders it impossible to open up the tapping holes and in some cases to get any blast into the furnace through the tuyere openings. Freeze-ups have been known to be so bad as to require the dismantling of the furnace in order to remove the obstruction.

The first thing to be done in an emergency of this sort is to get the tuyere nozzles open so that air can be blown into the furnace and to get the tapping holes open so that the iron and slag can be drawn off as melted. The old-time method of doing this was by means of a home-made kerosene blowpipe which is very easily put together by any pipe fitter and fed by a barrel of kerosene set on top of the furnace. With such an appliance, the tap hole usually can be melted open in from 12 to 48 hours. The modern furnaceman, however, has at his disposal much more efficient means. The electric arc burner will accomplish in hours what the older method required days to perform and the latest appliance, the oxygen blowpipe, requires only a few minutes to melt its way through several feet of metallic obstruction. There is a great deal of water-cooling around the blast furnace to protect the lining, tuyere nozzles, etc., at points where the heat is most intense. Frequently, these cooling devices spring a leak and, if the water passes into the furnace, it produces an effect on the quality of the product and fuel consumption proportional to its quantity. It is not always easy to tell if water is leaking, and even when the fact is suspected, it is sometimes difficult to locate the leak. Much skill on the part of the furnace manager is called for in this connection.

Occasionally, the end of a cooling device is melted off and a leak is produced of such a magnitude as to cause a steam explosion.

FIG. 6—A MODERN CHARCOAL FURNACE PLANT WITH HAND-FILLED STACK

The writer has seen a bronze casting, known as a cooler, and weighing probably 75 pounds, projected to a distance of 50 feet under these circumstances.

In addition to water leaks, water stoppage sometimes causes trouble, as, for example, when fish get through the pump strainers and into the small valves of the furnace piping. In this connection, most furnace managers can tell fish stories of which the following from the writer's experience is probably a fair sample.

Being called up one night with the information that the pumps would not work, the writer had the covers taken off the valve chambers and found therein a solid mass of fish. We took from two pumps 15 fish, none less than a foot long and some as much as 18 inches. Twice, later in the same night, we repeated the performance and as a net result of our night's work secured over 60 pounds of fish. In the morning, we found that the screen to our intake well had become displaced and that the fish came in there to get out of the current. A stick of dynamite in the well disposed of the remaining fish.

Not to dwell too long on the various incidents which make life interesting for the furnace manager, break-outs and gas explosions may be passed over as being too harrowing to discuss. As a result of more scientific management, however, all of these ills of the blast furnace are becoming less prevalent than in the past, and in furnace work as in medicine, we are coming to realize that an ounce of prevention is worth a pound of cure.

It is a popular fallacy that for a low cost of production a modern, well-equipped plant is the first essential. As a matter of fact, it is the quality and price of the raw materials which form the chief factors in determining the cost in making pig iron and some of the most successful plants, from the standpoint of dividends, are old and antiquated in their equipment.

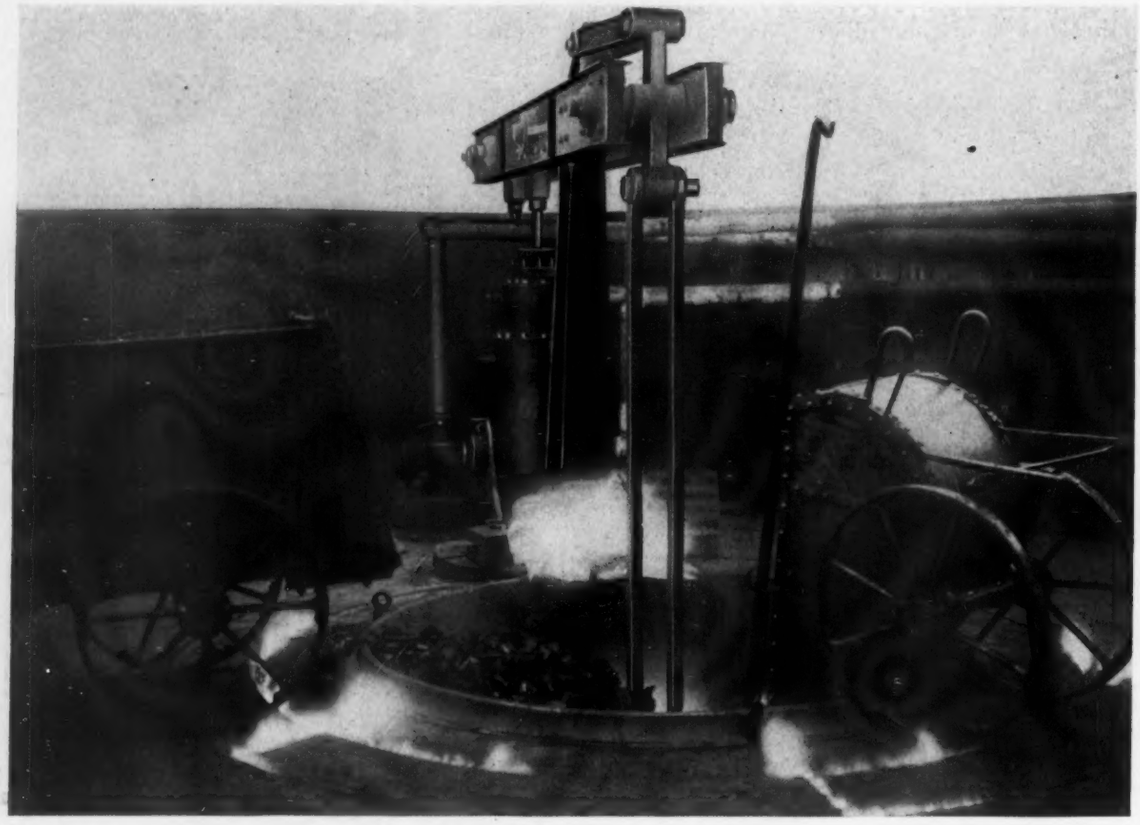


FIG. 7—CHARGING STAGE OF A HAND-FILLED BLAST FURNACE

The reason for this condition will be apparent from an inspection of the following table, which presents a summary of the average manufacturing costs[1] in several districts:

	Pittsburgh.		Chicago.		Alabama.	
	Tons.		Tons.		Tons.	
Ore	1.8	$9.00	1.8	$7.20	2.7	$3.42
Limestone	0.4	0.28	0.4	0.24	0.2	0.12
Coke	1.0	2.35	1.0	4.35	1.6	4.64
Labor		0.80		0.80		1.00
Sup. and relining		0.60		0.60		0.70
		$13.03		$13.19		$9.88

[1]The cost of limestone and coke in the above compilation is arbitrary and is not based on current quotations.

Improvements in equipment are usually made with a view to the elimination of labor, but it will be noted that the labor cost (in other words, the direct labor at the blast furnace only, for in the ultimate analysis the cost of the materials is also largely labor), is a comparatively small item ranging from 6 to 10 per cent of the total; hence, there is but small chance for saving here, and it frequently occurs that the reduction in manufacturing cost which is accomplished through the introduction of labor-saving machinery is more than offset by increased interest and depreciation charges. Nevertheless, such improvements are sometimes justified entirely aside from considerations of cost; for example, in districts where labor is very difficult to secure, or in the case of a furnace of large capacity where it is practically impossible to handle by hand the tremendous tonnage of raw materials.

On the other hand many mistakes have been made and much money wasted in the installation of expensive labor-saving machinery at plants of small capacity or not able to run regularly, and, therefore, having only a small output over which to distribute the heavy charges.

The greater part of the cost of making pig iron is in the raw materials, and assuming the price of these to be fixed, that is, ignoring the possibility of lowering mining and coking costs and concerning ourselves only with the blast furnace proper, the ore cost and the limestone cost are fixed. Thus, the only possibility is the reduction of fuel costs through lessening the consumption of this material.

It is in this connection that an efficient plant counts the most and any improvement which will lower the fuel requirement is usually a paying investment. The most commonly used means of accomplishing this is through heating the blast to a higher temperature by using larger and more powerful hot blast stoves. Another means, which is being widely adopted, is drying the blast by the Gayley process. Apparatus for the better preparation of the raw material, for example, crushing the limestone and sizing the ore, may also be placed under this head.

FIG. 8—GAS WASHERS INSTALLED AT A MODERN BLAST FURNACE PLANT

In addition to the items which we have previously set forth as belonging to manufacturing costs, the fixed charges and overhead expense are important and must not be overlooked. These charges are, of course, when reduced to per ton of iron, largely a function of the output, and it is highly important to have a large output, not only in order to have large profits, but also to

keep down costs. The one factor, which perhaps more than any other affects the output, is the rate at which the air is blown into the furnace. This is important, since the more air blown the faster the coke is burned and the faster the ore is smelted. It is, therefore, highly important to have good blowing equipment, and it is because so much attention has been given to this phase of furnace practice that American furnaces have led the world in large outputs.

Although the sole function of the iron ore is to furnish iron, still its content of this metal is not the only factor upon which its value depends. All iron ores are more or less impure and the percentage of silica, alumina, lime, phosphorus, manganese and other elements, as well as the physical structure and reducibility, or ease with which the oxygen is removed, are all of great importance.

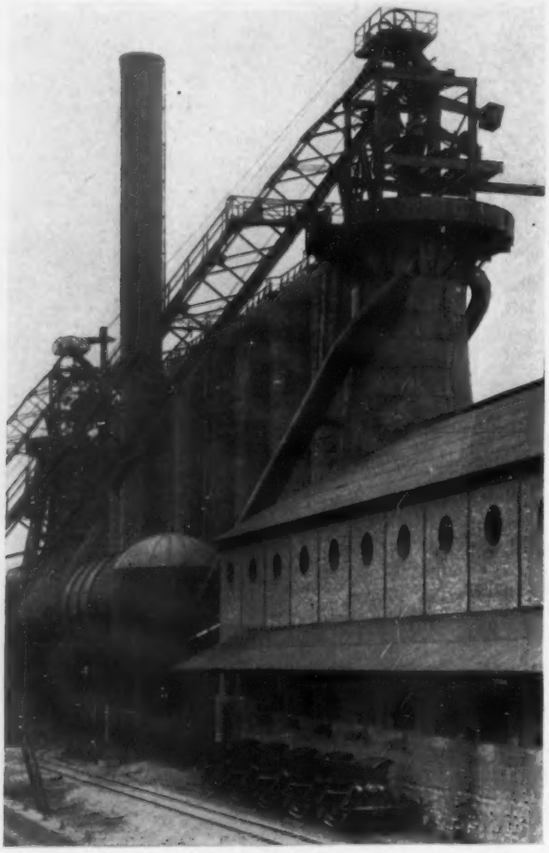


FIG. 9—SKIP HOISTS FOR MECHANICAL CHARGING

There is much misapprehension regarding the proper basis of valuation for iron ores. For example, the limey ores of Alabama are generally considered to be of very low grade, but while this is partly true their real value is much greater than is shown by the iron content alone. The high percentage of lime which they contain takes the place of an equal amount of limestone which would otherwise have to be used. For example, each ton of a red ore containing 27 per cent of iron 7 per cent of silica and 49 per cent of carbonate of lime, may be regarded as consisting of ½ ton of high grade ore containing about 54 per cent iron and 14 per cent silica, mixed with ½ ton of pure limestone. It is perhaps not generally appreciated that the worst feature of these southern red ores is not their low iron content, but their difficult reducibility.

The writer has derived a method of expressing the relative value of ores directly in dollars and cents. Although this method does not take into consideration the elements phosphorus and manganese, it nevertheless does furnish a means of comparing quantitatively the relative smelting values of widely differing classes of ore from widely separated localities. Assuming the following typical ores from various mining centers to be assembled and used at one point, the following would be their relative values as calculated by this method:

Name of ore:	Iron. per cent.	Silica, alumina. per cent.	Lime. per cent.	Relative value.
Lake Superior	53.0	11.0	....	$2.58
Virginia brown	45.0	20.0	....	1.64
Alabama hard red	35.0	15.0	18.0	1.17
Magnetic concentrates, east U. S.	60.0	12.0	1.0	2.32
Ironstone, Cleveland, Eng.	32.0	15.0	11.0	1.14
Minette, Germany	35.0	15.0	15.0	1.51

The fuels used in the blast furnace in the order of their importance are: Coke, charcoal, anthracite and raw bituminous coal. Coke is by far the most important and each year gains in pre-eminence as the supply of charcoal dwindles. Anthracite was at one time a very important fuel in this country, but it is metallurgically inferior to coke and the rapid driving and large outputs of the present day could never have been obtained with this fuel. Raw bituminous coal is not desirable for certain reasons and its use has never been attended with success save in a few unimportant and exceptional cases.

The requirements for a good blast furnace coke are rather severe since they embrace the combination of low sulphur, low ash and good physical structure. The exact limits permissible vary at different places and periods, but the amount of coal which will produce satisfactory coke is relatively small in comparison with our total resources of this fuel.

The great coke producing region of this country is the Appalachian coal field, extending from Pennsylvania to Alabama. Some of the best coking coal in the world is found in this field, notably in the Connellsville region, a small basin in southwestern Pennsylvania. We are coking some 50,000,000 tons of coal per annum and the drain on those

limited regions producing coke is, therefore, very great. It is stated that the Connellsville coal, in particular, is in imminent danger of exhaustion and the iron industry is looking more and more to the less exploited fields of West Virginia and eastern Kentucky.

Limestone is used in relatively small quantity and, as it is also of low value, it is of subordinate importance as compared with the other raw materials. As a minor economy, however, the purity of the stone will generally bear watching. The active ingredient being lime, the presence of silicious material not only lessens the lime by direct displacement, but also uses up some of the lime which is present. I have worked out an expression showing the relationship between the per cent of impurity and the value of the stone, and by its means, have shown that as little as 6 per cent of impurity lessens the value of the stone by as much as 20 per cent.

The product of the blast furnace we have hitherto spoken of as pig iron, but in reality there are many different varieties, each having some particular use. A list of the more commonly recognized grades of pig iron, with the approximate analysis of each, is as follows:

STEEL MAKING IRONS.

Grade.	Silicon, per cent.	Sulphur, per cent. under.	Phosphorus, per cent.	Manganese, per cent.
Bessemer	1.0 — 1.25	0.05	under 0.10	0.30—0.80
Basic	under 1.0	0.05	0.20 & up	0.20—1.50
Low phosphorus .	.....	0.05	0.02—0.05	.....

FOUNDRY IRONS.

Grade.	Silicon, per cent.	Sulphur, per cent. under.	Phosphorus, per cent.	Manganese, per cent.
Ferro-silicon	6.0 —15.0	0.05	.....	.....
Silvery	4.0 — 6.0	0.05	.....	.....
Soft	3.0 — 4.0	0.05	.....	.....
No. 1 foundry....	2.50— 3.0	0.05	0.20—1.20	0.20—1.50
No. 2 foundry....	2.0 — 2.50	0.05	0.20—1.20	0.20—1.50
No. 3 foundry....	1.50— 2.0	0.06	0.20—1.20	0.20—1.50
Forge	1.0 — 1.50	0.05	0.20—1.20	0.20—1.50
Malleable	0.75— 1.50	0.05	0.15—0.25	0.20—0.50

It will be noted that so far as foundry iron is concerned the grading is based chiefly on silicon and sulphur. One reason for this is that the phosphorus and manganese are fixed by the composition of the ore used, whereas the silicon and sulphur can be varied at will by slight changes in the method of operating the furnace. Since in many, perhaps the majority of cases, a blast furnace will be limited to a very few sources of supply, it follows that it will be limited also in the range of phosphorus and manganese in the iron it produces. For this reason, a given brand of iron will usually run fairly constant as regards phosphorus and manganese, although its silicon and sulphur can be varied as desired by the management. However, this condition, while common, is not universal, for some concerns possess a variety of ores and can, by mixing them, produce iron of any composition desired.

In this connection it may be well to emphasize the difference between a brand and a grade. A brand name being used to designate the iron made at a given furnace and from given ores, usually carries with it the idea of a fairly definite range of phosphorus and manganese. A given brand, however, may include the whole range of grades and, hence, may embrace the entire range of silicon and sulphur.

Reference to the market reports of THE IRON TRADE REVIEW will show that there is a considerable difference in the prices at which the various grades of iron are sold

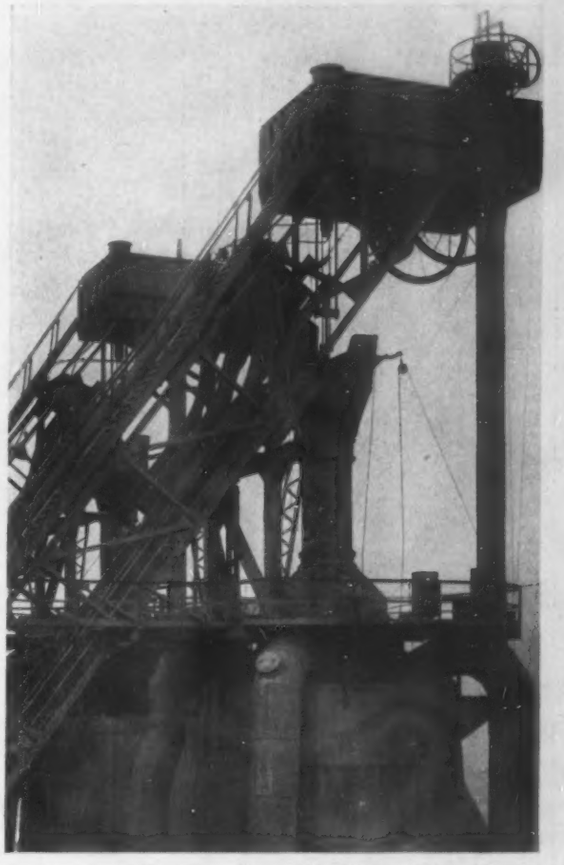


FIG. 10—FURNACE TOPS, SHOWING MECHANICAL CHARGING ARRANGEMENT

at any given point. For example, I find that on Dec. 5, 1912, the following were the quotations at Pittsburgh:

Bessemer	$18.15
Basic	17.40
No. 2 foundry.....	18.40
Forge	17.15

The differences in price are largely the reflection of differences in the cost of manufacture. In the case of Bessemer iron we must have low phosphorus, and since it is impossible to eliminate this element in the blast furnace we must start with an ore

which is low in phosphorus. Such ores being relatively scarce command a higher price, and hence the iron made from them will cost more, other things being equal.

No. 2 foundry iron is relatively high in silicon. In order to get this high silicon, it is necessary to run the furnace at a very high temperature, since the element is otherwise not readily reduced. This means that

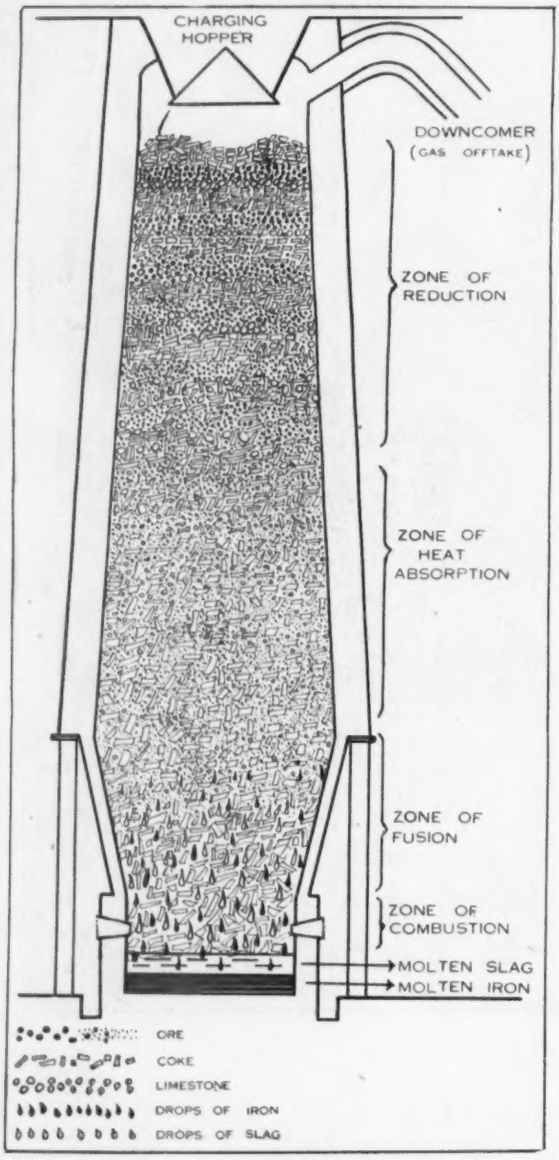


FIG. 11 — SECTION OF BLAST FURNACE, WHICH SHOWS THE SEQUENCE OF PRINCIPLE REACTIONS

a larger quantity of fuel must be used, which, of course, increases the fuel cost, while in addition, the output will be considerably decreased. This explains the relatively high cost of those pig irons which are high in silicon.

Basic and forge irons are low in silicon and may be high in phosphorus, hence are cheaper to make than the Bessemer and foundry grades. Basic iron, however, must be low in sulphur and in order to get a low sulphur together with low silicon it is necessary to run the furnace on a rather limey and, hence, rather refractory slag. This increases the fuel consumption and thus the cost of making basic iron is a little greater than in the case of forge.

In addition to the difference in the cost of different grades there is also a variation in the price of the same grade according as it is made in the south or the north. For example, the quotations at Cincinnati on Dec. 5, 1912, were, for southern No. 2 foundry, $17.25, and for northern No. 2 foundry, $17.95.

This difference, at first sight, appears to be an unjust discrimination against southern iron, but in reality there is a very good reason for it. The southern brands of iron are almost without exception very high in phosphorus and for this reason can be used alone on only a very limited class of work. For the great bulk of foundry work they can be used in only relatively small quantity, mixed with northern iron. It is this limitation of usefulness, due to high phosphorus content, which is the chief factor in lessening their value.

In addition to the classification afforded by the ordinary grading system pig iron also may be described from other points of view. According to the furnace practice, it is cold, warm or hot blast iron. On the basis of the fuel used in its manufacture, it is coke, anthracite or charcoal pig. According to the method of casting, it is sand, chill or machine cast. Finally, according to its chemical composition, it falls within the ordinary grading system. To completely describe any given brand we must classify it in all four ways. Thus, for example, we might say of a certain iron that it was hot blast, coke, chill cast, basic.

The effect of furnace practice, including such factors as the temperature of blast, rate of driving and nature of the ores on the quality of pig iron are not yet well understood. However, it is thought by many that there is some relation, and it is very generally agreed that iron made from cold or warm blast has certain qualities desirable, though rather intangible, which are not possessed by irons made with ordinary hot blast.

Blast Furnace Fuel

Of greater importance is the matter of fuel. There is, perhaps, no noticeable difference between coke and anthracite irons, but an iron made with charcoal as fuel is

unmistakably better than a coke iron having a similar chemical composition. For one thing, charcoal iron is normally much lower in sulphur since charcoal does not contain this impurity. In addition, there appears to be some intangible quality which enables the foundryman to secure better results on certain classes of work from charcoal iron.

The method of casting does not affect the commercial value of pig iron to any extent, although many foundrymen are coming to realize that there is a considerable advantage in using machine cast iron. It may, perhaps, be well to explain that the time-honored method of casting pig iron is to run it into sand molds. The resulting pigs have a considerable amount of sand adhering to them which, although its weight is allowed for in selling the iron, causes more or less trouble during the melting in the cupola.

In addition to this objection, there is always more or less irregularity in pig iron cast in the ordinary manner. The iron as it runs from the furnace may vary considerably in composition between the first part and the last part of a cast or tapping. For this reason there may be a wide variation in the composition of different pigs from the same cast and this variation may make trouble for the user of the iron.

A slight advance on the method of casting in sand molds is to have a set of permanent iron molds into which the iron is run in the same manner as before. This method does away with the sand, but does not avoid the irregularity in composition.

Machine-Cast Pig

In the method of machine casting, the iron is tapped from the blast furnace into a large receiving ladle where it becomes thoroughly mixed into a homogeneous liquid. From this ladle it is poured into iron molds which are carried on an endless belt. This method avoids the sand and secures perfect uniformity of composition. Comparatively few merchant furnaces at the present time are using this method of casting, but when the foundries awake to its advantage it will become more widely adopted.

The rate of growth of the iron industry in this country is one of the wonders of the age. Starting with practically nothing at the middle of the last century, our production has increased at an average rate of 100 per cent each decade until now it is our most important single manufacturing industry and with an annual output of about 30,000,000 tons of pig iron furnishes approximately one-fifth of the total freight traffic of our railroads.

The cause of this rapid growth is twofold; first, the presence in this country of unparalleled resources of coal and iron ore, both of excellent quality; second, the rapid increase in the demand for iron and steel products incidental to the growth and development of our country. Neither one of these factors without the other would have been sufficient to produce so great a result.

Forecast of Future Production

A forecast of the future is always interesting and in the case of the iron industry the law of increase has held so consistently in the past that we may feel reasonably sure that it will continue to do so at least for one or two decades in the future. On this basis, the diagram, Fig. 12, has been made and it will be noted that should the same law of increase continue to hold we

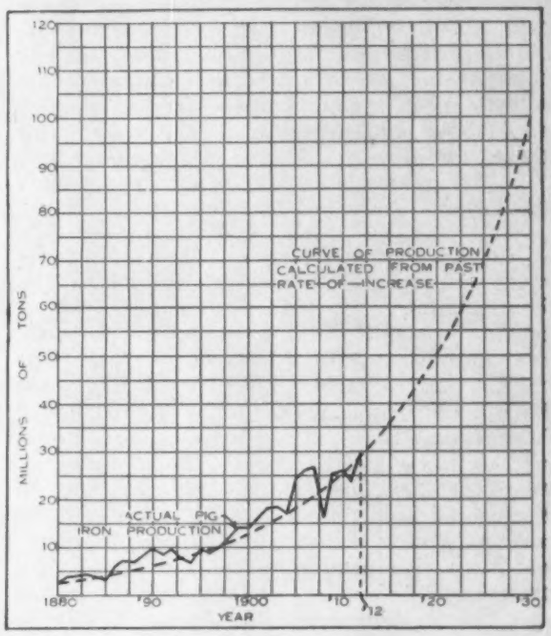


FIG. 12--CURVE OF PIG IRON PRODUCTION IN THE UNITED STATES

will produce about 50,000,000 tons of pig iron in 1920 and 100,000,000 tons in 1930.

On the other hand, it should be remembered that there are various factors operating to check the rate of production. Our constantly increasing stock of iron will soon reach such proportions that an enormous quantity of scrap will be available annually for remanufacture into finished products. Then, as our country becomes more thickly settled, there will be less demand for iron and steel for purposes of new construction, besides which the more extended use of cement will probably displace iron and steel from many uses where they are now considered necessary. These factors, in time, will lead to a departure from our curve of production.

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Regarding its immediate future, the entry of the Steel Corporation seems likely to prove of great value to the south, bringing an influx of new capital and hastening the adoption of more efficient methods. Other factors which should prove favorable to the district are the building of the Warrior river canal, which will open a water route between Birmingham and the Gulf; the completion of the Panama canal, which will place Alabama in an exceptionally good position to compete for the commerce of the Pacific coast and the far east; and finally, and most important of all, the continued development of the south itself with its rapidly increasing capacity for the consumption of iron and steel products.

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A Safe, Black Powder Charging Device

The accompanying illustration shows a device for charging gopher holes in open pit mines with black powder without danger of accidental explosion. It has been designed and patented by the Oliver Iron Mining Co., a subsidiary of the United States Steel Corporation. When powder holes are charged in the ordinary manner it frequently happens that the tools used in the operation strike a spark against some rock in the bottom of the hole, thus prematurely setting off the blast.

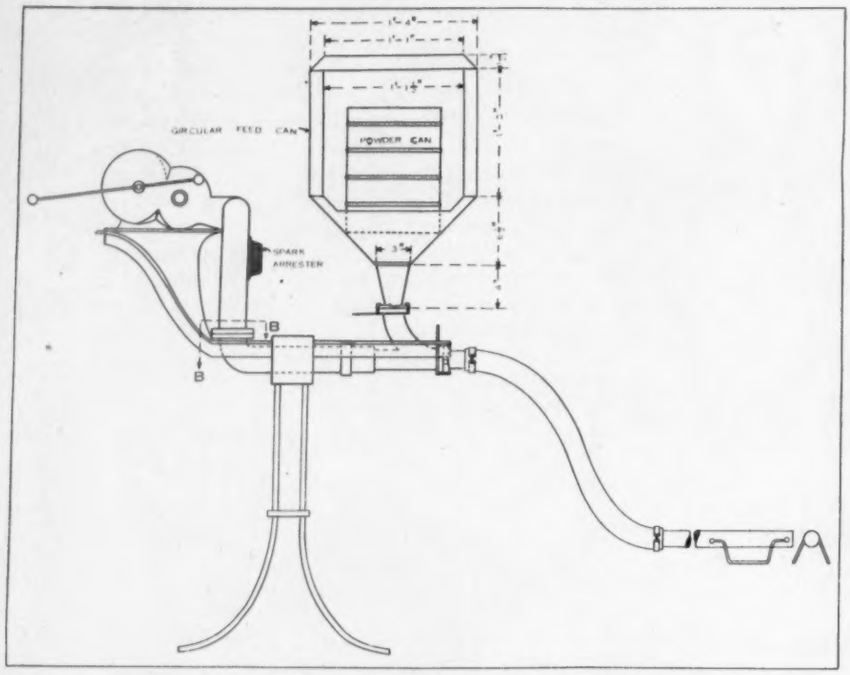

FIG. 1—POWDER CHARGING MACHINE

This device comprises a common blacksmith's forge, together with a funnel for holding the powder can and a nozzle consisting of three feet of flexible rubber hose terminating in a 20-foot copper pipe. The latter extends to the bottom of the powder hole when the machine is in operation. The powder feed funnel communicates with the blast tube in the manner shown in Fig. 1. The operation of the device is similar to that of a steam injector, the powder falling into the stream of air which carries it along to the end of the pipe. A spark arrester, consisting of a standard 12-mesh screen, is placed over the inlet of the forge in order to prevent any stray flame from entering the powder tube. The feed can and funnel protect the powder can on practically all sides, as indicated in Fig. 2. The entire mechanism is constructed of soft metal which will not strike sparks by contact or friction.

The forge is a standard, 10-inch blacksmith's fan, manufactured by the Champion Blower & Mfg. Co., Lancaster, Pa. The circular powder feed can, Fig. 1, is 16 inches outside diameter and 13½ inches high. The powder funnel is 6½ inches high with a 3-inch hole at the spout. The feed pipe is 2 inches in diameter and is fitted with a brass wire slider at the nose. The machine is designed to load 25 pounds of powder in 90 seconds.

Heat-Proof Soaking Pit Top

A soaking pit top, provided with means to prevent its destruction by intense heat from the furnace, has been devised by Horace E. Smythe, of Pittsburgh. The cover of the pit is divided into individual sections. A plunger or other moving device travels along the end of the sections and near each end carries a pivoted latch which may be swung to connect with lugs in any of the cover sections. In this way the plunger can be operated to open any desired part of the pit. An inclined track, adjacent to the wheels carrying the covers, causes the cover to rise as it moves from over the opening and means are provided whereby the axles of the wheels move downward after the cover is seated on the furnace.

The "continental horsepower" differs from the English and American horsepower by more than 1 per cent.

Nón-Corrosive, Iron-Nickel Alloy

Two patents recently have been issued to Robert B. Carnahan Jr., of Middletown, O., relating to the unusually pure iron, as regards resistance to corrosion, which the American Rolling Mill Co., of Middletown, O., is now making. It is said that the molten iron is purified to such an extent that its content of carbon, phosphorus, sulphur, silicon and manganese, combined, does not exceed 0.14 per cent, with oxygen reduced to not more than 0.05 per cent. It is also claimed that the corrosion-resisting qualities further may be increased by alloying with the iron a metal such as nickel, so that the finished alloy will contain approximately 99.3 per cent iron, 0.5 per cent nickel, not more than 0.14 per cent carbon, phosphorus, sulphur, silicon and manganese combined, and not more than 0.5 per cent oxygen. This alloy may be made in an open-hearth furnace by first refining the iron to the condition indicated, adding the alloying metal and then pouring the molten mass into a ladle containing a deoxidizing agent, such as aluminum, in the proportion of 2½ pounds per ton. The proportion of alloying metal added is determined by the use to which it is to be put, consistent with the cost of the nickel. The inventor claims that an alloy can be made which practically will be proof against corrosion if the high cost is justified by the results.

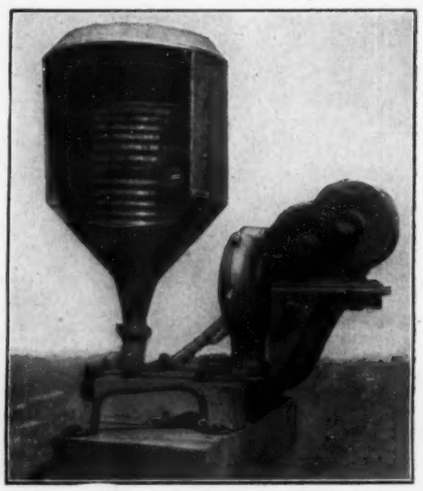

FIG. 2—POWDER CHARGING MACHINE, SHOWING METHOD OF INSERTING POWDER CAN

Although centrifugal pumps have been used since about 1880 for working against high heads, they have come into vogue in boiler plants only within the last five years.

The Iron Ore Deposits of the Southern States

The Extent of These Ore Bodies and Their Formation, With a Discussion of Their Adaptability to the Manufacture of Iron and Steel

By Edwin C Eckel

DURING the past few years both professional and public attention has been directed toward the iron ores of the southern United States, to such an extent that at times the unwonted—and unwanted—publicity has become embarrassing rather than advantageous to those engaged in mining and smelting these ores. In spite of all the political and legal discussion of various phases of the subject, there still seems to be material for a brief presentation of the commercial and geological relations of the southern iron ores; and this will be attempted in the present paper. In the past decade a large supply of detailed reports on individual properties or on particular districts, has become available, and it will be of advantage to use the data in such a way as to bring out the more general features of the subject. In doing this the writer has drawn freely from his own notes, as well as from published descriptions of the various fields.

Before taking up the discussion of individual ore districts, a few general statements will be made regarding southern ores, in an attempt to clear up misapprehensions which still exist. The principal points to which attention should be directed, are as follows:

1.—At an early stage in southern iron development, and before the Mesabi ores had begun to supply the northern markets, there was a widespread belief that somewhere in the south it would be possible to develop ores in such tonnages, and under such traffic conditions, as to make them available as an auxiliary supply for Pittsburgh and Ohio furnaces. This theory has cost a large amount of money in the way of exploration, and is still encountered. With two exceptions, no southern ore fields are likely to be of any use to so-called northern furnaces. The two exceptions are the Texas brown ore field, which will be discussed later in this paper, and a Virginia-West Virginia field which promises a fair tonnage of rather low grade ore. The Texas shipments are feasible today, but the other field is merely a possibility of the future.

2.—The second point requiring attention is the phosphorus content of

Edwin C Eckel

Edwin C. Eckel, 725 Munsey building, Washington, D. C., is a mining engineer of wide experience and in recent years has specialized in iron and manganese ores, cement materials, etc., with particular reference to southern supplies. He was born in New York City in 1875 and graduated from the Engineering School of New York University in 1896 with the degree of civil engineer. His post-graduate work involved a study of geology and he engaged in masonry construction up to 1899. From 1900 to 1902 he was assistant geologist of the state of New York and he was geologist of the United States Geological Survey from 1901 to 1907, having been in charge of the section of iron ores, etc., for one year. In 1907 he resigned to engage in private practice. He is the author of several technical books and has written official reports on various southern and eastern iron districts. He served as expert on southern ores and the general ore-reserve situation for the counsel of the United States Steel Corporation in the Stanley investigation and dissolution suit.

FIG. 1—BROWN ORE MINE AT ORISKANY, VA.

the southern ores. With a few unimportant exceptions, no ores approaching Bessemer grade occur anywhere in the south. If is true that samples showing low phosphorus can be obtained in many localities, but there is no considerable tonnage of such ores available anywhere. This point is mentioned because it is still a cause of useless expense to optimistic investigators.

3.—The two points mentioned have been warnings against undue optimism, but the northern-trained engineer is usually too conservative with regard to the question of tonnages, so that a warning in the other direction will be timely. In this connection it can be stated fairly, that in dealing with southern red ores, we are dealing with the most continuous and, in general, the most uniform ores known anywhere, and that when this fact is realized we can hazard tonnage estimates on data which would be too scanty to serve as a fair basis when considering ores of any other type. With regard to brown ores, the case is different, but even here careful work will usually prevent any serious and expensive error.

4.—The final point to be borne in mind is that all of these ores are still cheap, when compared with equally good ores to be found elsewhere in the United States. This permits of a large amount of detailed examination before buying or developing a southern ore property, without running up the total cost of the ore in the ground, to over a few cents per ton. Under these circumstances, there is little excuse for hasty or careless purchases, and it is generally possible to have a very definite idea as to total tonnage and average grade before much money has been invested in the transaction.

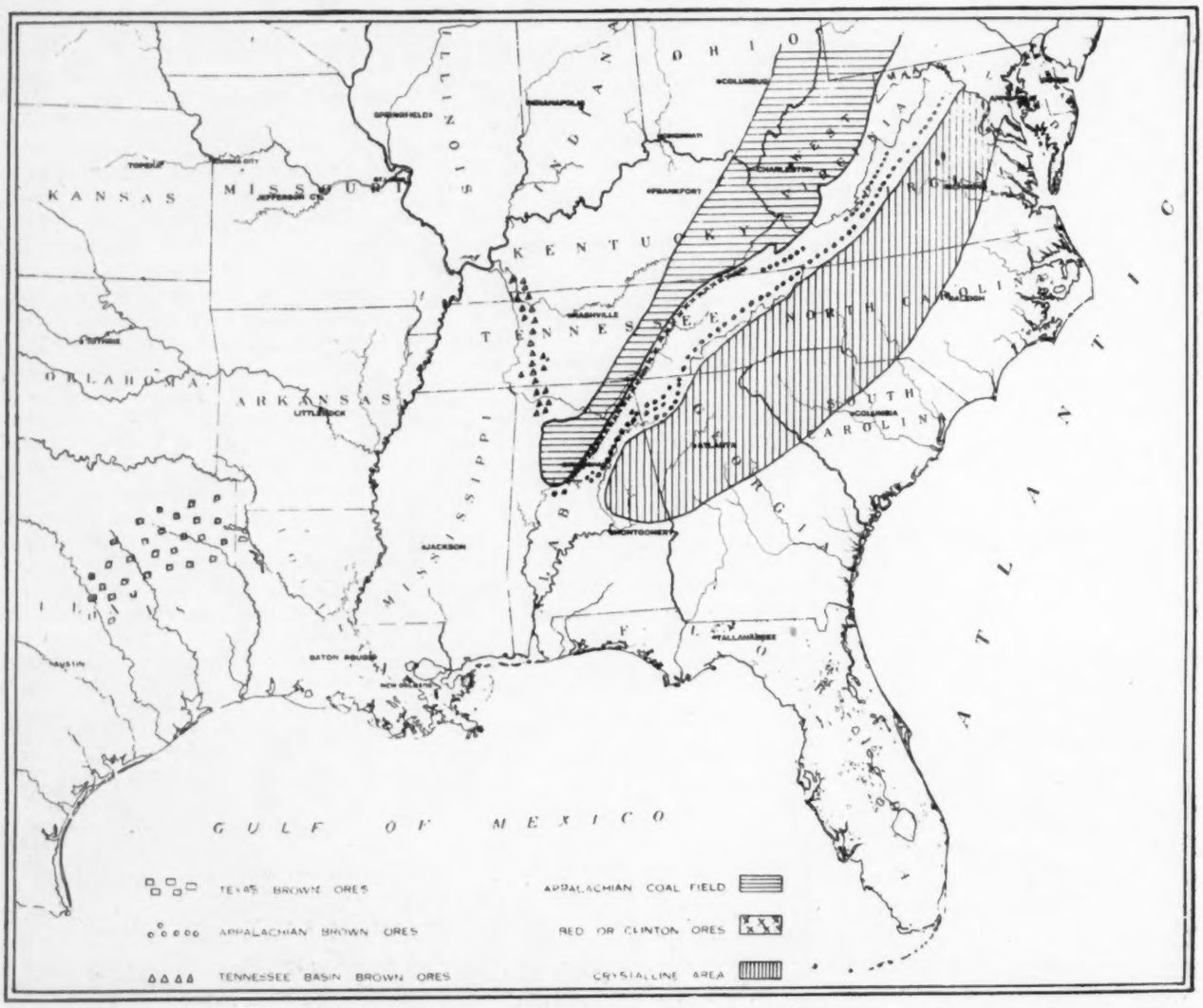

FIG. 2—MAP OF THE SOUTHEASTERN DISTRICT OF THE UNITED STATES, SHOWING THE IRON ORE DISTRICTS

Principal Southern Ore Fields

It would, of course, be possible to take up the iron ore resources of the south state by state, and supply descriptions of most of the known deposits, as an immense amount of data is now available on these subjects. But in doing this, the details introduced would inevitably prevent the reader from obtaining any clear idea of the general situation. To avoid confusion, it seems advisable to describe the ores in their larger and more general grouping, and to precede this discussion of the leading ore areas with a brief review of the principal types of ores.

Southern iron ores, as now mined and used, include red and specular hematites, brown ores and magnetites. The same mineralogical species are present, therefore, as have been long familiar to northern furnacemen. But the proportions of the different types, and their relative importance, are strikingly different in the two parts of the country. Hard hematites and magnetites, so common in the lake, highland and Adirondack areas, are of little present importance in the south, though deposits of ore of these kinds are

known to exist, are now mined, and may become of greater importance. At present, however, the chief southern grades are of two types, red or Clinton hematites and brown ores.

Red Hematites

The red hematites are by far the most characteristic, as well as the most important of the southern iron ores. They occur as distinct stratified beds in the Clinton formation of Silurian age, and throughout a large portion of the southeastern United States workable ore beds of this type will be found wherever rocks of that formation are exposed. The red ores are known locally as red, fossil or oolitic ores, according to their more prominent characteristics in any given locality. The ore beds extend almost uninterruptedly from Virginia to central Alabama, outcropping along the eastern edge of the Cumberland plateau, and being, therefore, almost always within easy reach of workable coal beds. They are developed in greatest thickness in the Birmingham region of northern Alabama, but are commercially workable elsewhere in Alabama, as well as throughout most of northwest Georgia, eastern Tennessee, and at a few points in Virginia. At and near the surface the action of surface waters has leached out most of the lime carbonate which the red ores originally contained. The ores near the outcrop, therefore, usually are low in lime and relatively rich in iron, ranging often as high as 50 to 60 per cent metallic iron. But this is purely a superficial phenomenon, and when the beds are followed underground to a point where leaching has not occurred, the ore is found to carry considerable lime carbonate, and to range from 30 to 40 per cent in metallic iron.

The brown hematites, or brown ores, as they are more simply called, are hydrated iron oxides, carrying, even when pure, from 10 to 15 per cent of combined water. A brown ore running 55 per cent metallic iron, therefore, would be a much purer material than a hard hematite or magnetite carring the same iron percentage. The brown ores, however, usually occur in very irregular deposits, and almost inevitably require concentration to bring them up to their normal commercial grade of 40 to 50 per cent metallic iron. Much better concentrating work would be easily possible, but is not at present justified by the ordinary price of southern pig iron. As to geographic distribution, brown ores are of so wide occurrence that at first sight it may seem impossible to group the deposits in any comprehensive way. It will be found, however, that the brown ore output, as well as most of that which will be utilized in the near future, will be obtained from the following districts:

1.—In the Appalachian valley and its foothills, extending from the northern line of Virginia to central Alabama.

2.—In northwestern Alabama, middle Tennessee and western Kentucky, along the Tennessee river drainage area.

3.—In northeastern Texas.

In all of these districts extensive brown ore deposits occur, and the total tonnages available are very large, being estimated at hundreds of millions of tons. The districts vary in the character and association of their ores, as well as in their present degree of development.

Finally, it is necessary to mention the occurrence of deposits of magnetite and specular hematite along the Blue Ridge and related areas in central Virginia, the western portion of the Carolinas and central Georgia and Alabama. Most of these deposits are badly located so far as fuel and transportation are concerned, so that they have not been seriously developed except at a few points. Their concentrating possibilities, however, are such that they offer much hope for the near future.

Principal Southern Ore Fields

In the discussion of the principal southern ore fields, they will be considered in the following groups:

1.—Red or Clinton ores.

2.—Brown ores, Appalachian region.

3.—Brown ores, Tennessee river region.

4.—Brown ores, northeast Texas.

5.—Magnetites and allied ores of the crystalline area.

It is true that this grouping omits some ores which have been of importance in the past, or may become important in the future, but it covers substantially all of the tonnage now used and the isolated deposits which do not fall in any of the groups named can safely be disregarded in any general discussion of the subject.

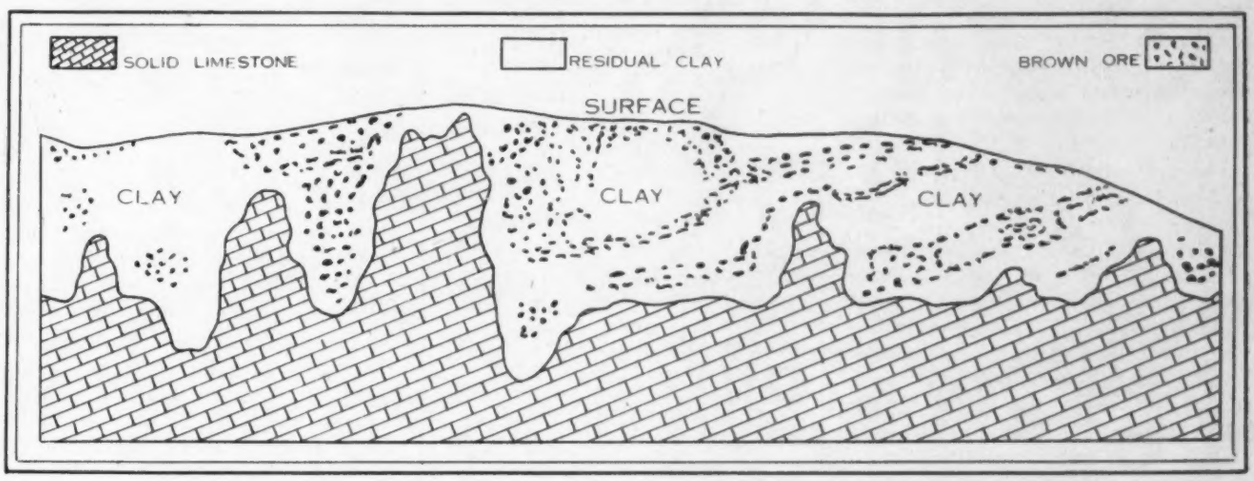

FIG. 3—SECTION ACROSS DEPOSIT OF IRON ORE IN RESIDUAL CLAY OVERLYING LIMESTONE

The red or Clinton hematites are the backbone of the southern iron and steel industry. They occur in enormous tonnages, estimated at thousands of millions of tons; they are cheaply mined, and in any given mine they are very uniform in composition and character; their grade, in view of all industrial conditions, is very satisfactory. This statement should not be interpreted as meaning that they contain high percentages of metallic iron, as their normal range is only from 33 to 40 per cent iron. In most of their developed area, the Clinton red ores carry high percentages of lime carbonate, so that their silica is not as high as the low iron content might seem to indicate. This

as well as a number of more directly commercial factors, must be taken into account when a comparison is made between these ores and other ores of a more siliceous type.

Distribution of Red Ores

In an earlier paragraph the geographical distribution of the red ores was outlined briefly. We will now recur to this phase of the subject. Before taking up the question of their distribution in the south, it may be well to note that ores of exactly similar type and age have long been known and worked in New York, Wisconsin, Nova Scotia and Newfoundland; while the oolitic ores of the Lorraine-Luxemburg district are closely similar in type, but differ in geologic age. We are dealing, therefore, with a very widespread type of ore, and with one which today is the main supply of the Canadian, German, Belgian and French steel industries. Ores of purely sedimentary origin are, in fact, of far more importance, both as regards tonnage and industrial use, than would be suspected on reference to an ordinary textbook on ore deposits.

The red oolitic ores are associated with rocks of Silurian age, and occur as definite beds in the so-called Clinton formation. In the southern United States, Clinton rocks outcrop along the eastern flank of the coal fields, from Maryland to central Alabama. The ore beds are almost continuous throughout this great extent, though in Virginia there are few points at which they attain workable thickness and grade. Through eastern Tennessee, however, the red ores become of importance, and in Alabama they reach their maximum thickness and, in general, their best grade. Careless overestimates of their grade have, in the past, led to bitter disappointment and heavy loss, as mere mention of Big Stone Gap, Middlesboro, Fort Payne and Gadsden will serve to recall; but against these we may fairly set Birmingham, Dayton, Rockwood and a number of other successful iron manufacturing localities where these ores have been the main source of supply. Birmingham, of course, represents the Clinton ore at its best development.

Character of Ore Beds

In the Birmingham district the Clinton formation shows, at almost every point where it is carefully examined, from three to five distinct beds of red ore. Only two of these, however, are of sufficient extent, grade and continuity to be seriously considered as factors in the ore situation. The two important beds or seams have been named respectively the Irondale seam and the Big seam. Of these the Big seam is the thickest and most extensive. It lies above the Irondale geologically and topographically, the interval between the two varying from 1 to 10 feet, and is occupied by shale and occasionally, sandstone beds.

The Big Seam itself varies from 15 to 30 feet in thickness, but of this total only from 7 to 12 feet of ore are good enough to work at present. Throughout most of the district the lower portion of the Big Seam is too low grade for present use. The Irondale seam ranges from 4 to 6 feet in thickness in the area where it is worked. Further data on these two seams, as they are developed in the more important portion of the Birmingham district, are quoted from *Bulletin* 400, United States geological survey, in the accompanying table II.

Table I

DISTRIBUTION OF SOUTHERN IRON ORES

The following table, in compact form, shows the distribution of iron ores in the south. In this summary, S denotes that shipments have been made in recent years; U, that undeveloped deposits are known to exist, and O, that no ore of this type is known to occur in the given state. When the deposits are of great importance, whether now worked or not, they are indicated by the italic letter, *S* or *U*:

State.	Magnetite.	Specular hematite.	Clinton or red hematite.	Brown ore.
Alabama	U	*U*	*S*	*S*
Arkansas	U	U	O	U
Florida	O	O	O	O
Georgia	U	U	*S*	*S*
Kentucky	O	O	S	*S*
Louisiana	O	O	O	U
Maryland	U	U	U	S
Mississippi	O	O	O	U
Missouri	S	S	O	S
N. Carolina	*S*	U	O	U
Oklahoma	U	U	O	U
S. Carolina	U	O	O	O
Tennessee	U	O	*S*	*S*
Texas	U	U	O	*S*
Virginia	*S*	*S*	*U*	*S*
W. Virginia	O	O	U	*S*

Mining and Concentration

All of the red ore mines in the Birmingham district started originally as open cuts along the outcrop, the product being at first soft, or leached ore, taken out by hand labor. At a few points in the district mines of this simple type are still in operation, but in most instances they have gone much further, and are now completely underground operations, operated by slopes or inclines. In the near future we may expect to find a third type of mine developed, operated by shafts.

The ore beds on Red Mountain dip eastward at angles of 15 to 30 degrees. In the average mine the workings consist of a slope driven down the dip in the ore, with entries turned off at intervals from this slope. At several points on the mountain, however, ravines have conveniently cut through the ore and exposed the ore beds for some distance along the sides of the ravines. In such cases, it is possible to replace the underground slope by an inclined track laid in the ravine, while drifts run into the banks at intervals take the place of the entries. In either case the ore is worked out in rooms, and the pillars are finally recovered. The total cost per ton of ore at the mouth of the mine may range from 75 cents to $1, or slightly more, the difference being largely in the amounts charged off for amortization, and the manner in which the mine and its machinery are kept up. Extreme parsimony in these directions makes a good showing for a few years, but is apt to have painful results later.

All the ore now shipped from Red Mountain mines is crushed to a convenient size for the furnace charge, and at present no concentration of any kind is practiced. The fact is, however, that in addition to the large reserves of commercial ore known to exist, there are also several thousand million tons of lower grade ores in the district which will, at some future date, lead to attempts to utilize this poorer ore by means of concentration.

Brown Ores of the Appalachian Valley

The red ores which have been discussed are of the sedimentary type, occurring as definite beds inter-stratified with other rocks, and their place in the geologic system is fixed very closely. The brown ores, which are now to be considered, are very different in origin and associations. They occur as scattered deposits, overlying rocks of different geologic ages, and the brown ore deposits are of much later age than the rocks with which they are now associated. They have originated, in most cases, through deposition from iron-charged waters, the deposition taking place near the ground surface, and being particularly apt to occur where beds of limestone offered a resting place for the iron minerals.

The principal brown ore deposits of the south, as now developed, occur in the Appalachian valley, or in its foothills. This limestone valley is almost continuous from Canada to Alabama, and throughout its entire extent it presents almost ideal opportunities for the formation of brown

ore deposits. Flanked on the east by iron-bearing crystalline rocks, which form the highlands of New York and New Jersey, the South Mountain and Blue Ridge of Pennsylvania and Virginia, and similar ranges further south, the progress of rock decay has for ages furnished a supply of iron-charged surface waters. The rocks of the valley itself, consisting chiefly of limestone with interbedded shales and sand stones, all containing iron in small but persistent amounts, are more immediate sources of supply. The iron-bearing waters have found excellent locations for the depositions of their iron in the valley and its foot hills, whose rocks vary in composition, solubility and hardness, and dip at varying angles. The topographic features which result from these conditions have influenced the location and the type of brown ore deposits which occur in various portions of the valley.

The net result of these geologic conditions is that now, reaching all the way from Vermont to central Alabama, we find more or less extensive deposits of brown ore scattered along the Appalachian valley region. Occasionally, workable deposits are found well out in the valley itself, but usually they occur along its flanking hills.

Brown Ore Deposits

Throughout most of the range, the heaviest deposits are along the eastern side of the valley, but the well-known Oriskany ores of Virginia, long worked at Longdale, Lowmoor and other mines, are on its western side, and the Woodstock and Champion districts of Alabama are also west of the main limestone valley. In Tennessee, northern Alabama, northeast Georgia and southwestern Virginia, however, the brown ore mines which have become serious shippers are principally located close to the eastern side of the valley, and in some cases the deposits lie well up on the ridges flanking the eastern edge.

In practically all cases, except in the Virginia Oriskany district, the brown ore occurs associated with limestones, shales and quartzites of Cambrian or Lower Silurian age, or with the clays and other residual material derived from the decay of these rocks. The ores do not form continuous beds, but are in irregular deposits. These deposits are apt to be richest at or near the surface, and to disappear entirely when they are followed deep enough to strike solid rock. Their irregularities of form and richness are very pronounced, but usually a careful study of local geologic features will enable both prospecting and working to be carried on with reasonable economy and certainty. In places, where the ores were originally concentrated along particular beds of rock, the existing deposit still shows some approach to alternations of rich and barren layers; in other instances there is little approach to system in the distribution of the ore throughout the clay.

This last note brings us to another feature of brown ore mining. The ore itself, at its theoretical maximum of purity, could conceivably carry from 60 to 66 per cent metallic iron, according to the particular iron material which happened to form the bulk of the ore. But as a matter of fact, even the most careful hand mining, in the richest deposits, rarely gives ore grading over 55 per cent metallic iron, and by far the bulk of our southern brown ores, after washing and jigging, will not yield over 50 per cent iron. In many districts even this grade cannot be attained in a commercial way, and one important district does not give much over 42 per cent iron for steady shipments.

Table II

EXTENT OF IRONDALE AND BIG SEAMS, WITH CHEMICAL ANALYSIS OF THE ORES

Ore seam and locality.	Length of outcrop, feet.	Average thickness of minable ore at outcrop, feet.	Dip in Red Mountain. degrees.	Average composition (hard ores). Fe, per cent.	SiO_2 per cent.	CaO, per cent.
Irondale seam:—						
Morrow Gap to Bald Eagle	11,000	4.25	15—18	35.14	31.23	4.55
Bald Eagle to Red Gap	15,000	4.5	15—18	33.67	22.54	12.89
Red Gap to Helen-Bess	18,200	4	15—20	35.81	25.57	8.48
Helen-Bess to Hedona	6,800	3.5	17—22	36.12	19.60	14.29
Big seam:—						
Bald Eagle to Red Gap	15,000	7	15—18	35.87	26.54	10.92
Red Gap to Helen-Bess	18,200	8	15—20	34.77	30.91	7.73
Helen-Bess to Hedona	6,800	10	17—22	32.01	32.81	8.51
Hedona to Walker Gap	14,500	10	20—25	35.40	25.90	9.50
Walker Gap to Graces Gap	5,000	12	20—25	36.26	19.02	13.50
Graces Gap to Spring Gap	11,700	9.5	18—25	34.90	14.86	16.98
Spring Gap to Woodward No. 2	14,200	9	18—32	36.97	12.58	16.12
Woodward No. 2 to Readers Gap	15,500	10.75	20—30	35.10	10.64	19.31
Readers Gap to Potter	10,000	8.5	18—40	35.44	11.20	18.25
Potter to Sparks Gap	5,200	5.5	30—45	33.28	12.18	19.41

Appalachian Ores

In producing a ton of 50 per cent ore, it may be necessary to mine 2 to 15 tons of crude ore dirt, according to the district. The bulk of the Appalachian output, however, probably comes from ores which concentrate at ratios of between 3:1 and 5:1. A large portion of this tonnage is produced by simple washing without jigging, and even a casual study of the Appalachian ores will serve to show that this leaves large margin for improvement. As the Appalachian brown ore deposits still contain, so far as can be estimated, several hundreds of millions of tons of good ore, there is obviously reason to pay more attention to questions of more careful methods of mining and concentration.

Commercially, it can be said that the Appalachian brown ores furnish the entire supply for all of the Virginia furnaces; for several in east Tennessee; for a small group in northern Alabama and northwest Georgia, and that they furnish a part of the supply for the furnaces of the Birmingham district.

Brown Ores of the Tennessee Drainage Area

Second to the Appalachian region so far as present developments are concerned, but probably far outranking it in unworked tonnages, is the region lying in northwestern Alabama, middle Tennessee and western Kentucky, along the Tennessee river drainage and in the areas drained by its main tributaries. This great iron region has certain interesting historical associations, as the first furnace in Alabama was built to utilize these ores; and, at the other end of the district, lies the scene of the first serious attempt at promotion by Thomas C. Lawson—the Three Rivers project. Scattered all over the intervening territory are the ruins of old charcoal furnaces and forges, while six or eight furnaces are still in blast on these ores in Alabama and Tennessee.

This brown ore region lies entirely to the west of the coal fields of Alabama and Tennessee, and the ores differ in geologic associations from those of the Appalachian valley. They are associated with limestones, it is true, but in the Tennessee area these limestones are of lower carbonifer-

ous age, in place of the Cambrian and Silurian limestones, which are associated with the Appalachian valley ores. Another point of difference, the result of the differing geologic history of the two regions, is with regard to the attitude of the rocks and the ore deposits. In the Appalachian region the rocks have been greatly folded and tilted, so that both ores and associated rocks rarely lie in even approximately horizontal attitudes. In the Tennessee drainage area, on the other hand, the folding and tilting have been very slight; the rocks dip at very low angles and the brown ore deposits mantle over them in comparatively regular form; regular for brown ores—as they are still highly pockety and irregular as compared with red ores or any other well-known type.

Tennessee Drainage Area

The area included in the Tennessee drainage, which may fairly be expected to be productive of more or less brown ore throughout its extent, is very large. From its southernmost point below Russellville, Ala., to its northern limit in Kentucky, the distance is almost 200 miles. Its width, from east to west, varies from 5 to 20 miles, or more. Therefore, there is an extreme area of perhaps 2,000 square miles, over which brown ore deposits are scattered more or less thickly. Of this total area, close geologic study will probably rule out nine-tenths, as not being likely to contain any large deposits, but this leaves several hundred square miles of very promising territory within which deposits of serious size are likely to occur, and within which a very large tonnage of workable ore has already been developed.

As to grade, the ores of the Tennessee basin seem to fall somewhere near the average of the Appalachian region ores. They never, for example, are as poor as the brown ores of the Virginia Oriskany district; while on the other hand, they do not, on the average, grade as high as some of the best Virginia and Alabama Appalachian ores. The concentrating ratio is also about average. Few deposits in the Tennessee basin will concentrate at a 5:3 ratio, which is occasionally found further east; but on the other hand none of these Tennessee basin ores require a 10:1 or greater concentration, which occasionally is necessary in southwest Virginia. Taking all of these factors into consideration, it can be stated that the Tennessee basin now contains a far larger tonnage of brown ore which can be profitably mined and concentrated to a 48 or 50 per cent grade than do all of the Appalachian valley deposits.

Brown Ores of Northeastern Texas

The brown ore field of northeastern Texas covers a very extensive area, deposits being known to occur in at least the following 20 counties: Camp, Cass, Marion, Morris, Upshur, Wood, Harrison, Van Zandt, Gregg, Panola, Smith, Rusk, Cherokee, Henderson, Anderson, Houston, Nacodoches, Shelby, Sabine and San Augustine. Within this field Kennedy has mapped iron ore districts aggregating over 1,000 square miles in area. There is no question whatever as to the areal extent or large total tonnage of the ore occurring in this field, and estimates of total reserves ranging 500,000,000 up to 1,000,000,000 tons may be accepted as well within the truth. The possibility of commercial utilization depends upon factors other than total tonnage.

The ores occur in approximately horizontal beds, associated with clays, sands and green sands of Tertiary age. The ore beds are conformable to the associated beds and often are enclosed in them, but this is not necessarily proof that the ores originated at the same time as the enclosing beds. On the contrary, the probability seems to be that the ores, as now found, were formed at a considerably later date than the sands and clays, though these associated formations probably contributed the iron required for the ore formation. To the miner the question of origin has, in this case, but one practical bearing, in other words, on the probability of finding in depth richer or larger deposits than those now exposed at the surface or in shallow diggings. This point fortunately is not involved in any theoretical differences of opinion as to the origin of the Texas brown ores. Under any probable hypothesis it may as well be understood clearly that—

(1) As to size of deposit, there is no probability that thicker beds will occur at deeper levels, and

(2) As to richness of ores, the chances are that the richest ores will be found at or near the surface.

Ore Formation

The ore occurs in the form of relatively large nodules, or in platey layers, and in either case can be readily and thoroughly cleaned from the accompanying sand. The ore fragments themselves, however, contain fine sand grains, so that the silica content of the clean ore is usually higher than might be expected.

An extensive series of analyses made on samples collected by Kennedy gave the following average result: Metallic iron, 46.63 per cent; silica, 14.47 per cent; alumina, 8.17 per cent; sulphur, 0.083 per cent, and phosphorus, 0.172 per cent.

This average covers the results of 131 samples, taken in every part of the Texas brown ore area. Of course individual samples give much higher results. There are also authentic furnace records showing long runs on ore averaging 55 to 57 per cent iron, but these were, in the cases examined, on ore which had been dried previous to charging. It seems probable that by care in handling, shipments could be made for large tonnages averaging about 50 per cent iron, but much more should not be expected.

Ore is Near Surface

The ores are found on the tops of plateaus, separated by sharp little ravines. Along the sides of the ravines ore fragments often give an erroneous idea of great average thickness, but the deposits, when in place, range from 1 foot to 8 feet or 10 feet thick, and the average over the entire field will probably fall between 2 and 3 feet. In places the ore is at the surface, in others it is covered by a few inches to 5 or 6 feet of sand.

Generally, the ores are of good grade and are present in large total quantity, but thin beds. They can be mined cheaply and easily at any given point and the whole problem is one of assembling a tonnage from a series of scattered operations. Transportation to the coast is now available at a fair rate, and the ores could be laid down in Baltimore or other Atlantic coast points at prices to compete with Cuban ores.

It must be borne in mind that, in this discussion of the Texas brown ore situation, I have had in mind the whole field, and not any individual property. In an area of this size it is probable that, at some points, the ore bodies show greater thicknesses than I have noted, and it is entirely possible that large tonnages may be mined and washed to show a higher grade than has been assumed in the preceding discussion.

The four districts which have been considered carry ores differing in grade, origin and associations, but each of the districts is fairly uniform, within itself, in these regards. This

is not the case with the group of ores which remain to be briefly mentioned, for they differ among themselves very widely in all of these respects. Their only point of agreement is in the area which includes them, and in the general type of rocks with which they are associated.

In Fig. 2 it will be noted that the Appalachian valley is bordered on the east by a wide area of crystalline rocks. These rocks, some of which are igneous and others of metamorphic origin, include slates, schists, gneisses, granites, etc. Scattered along this area we find, at intervals, deposits of iron ore of three general types. There are magnetite deposits, often of great size and purity; specular hematites, varying in grade and character, and brown ores, occurring as gossan capping pyrite deposits.

Some of the ores of the crystalline area have been long worked and are well-known geologically and industrially. Among these may be noted the magnetites of Cranberry, N. C.; the magnetites and hematites of Pittsville and Rocky Mount, Va.; and the brown gossan ores of Ducktown, Tenn. But in addition to these known and developed deposits, there is a large number of promising areas which are held back chiefly by lack of transportation facilities. During the past decade three new railroads have crossed the crystalline area at widely separated points. The Virginian, the Clinchfield and the Atlanta, Birmingham and Atlantic railways each has opened new iron territory, and this process of development, by means of new transportation lines, may be expected to continue until the ores of the crystalline area become better represented among the shipment totals.

Germany Highly Prosperous in Spite of Wars

Production Heavy and Prices Advance—Political Uncertainty Causes Some Hesitation, But General Outlook is Favorable

TWO political factors that might have been expected to disturb the even course of the German or any other continental iron market during this year may be said up to the present not to have affected it at all; unless it be assumed that but for these two factors, the Italo-Turkish and the Balkan wars, business might have been even much better than it has been. One of the remarkable features of the German iron industry and market has been that notwithstanding these disturbing elements, the progress of the industry has been steady and buoyant, and the year appears to be closing with hardly any effects from the political disturbances, excepting here and there what appears to be a shortening of sail in dread of possible complications of a more serious nature than those already existing rather than as a direct result of the wars to which allusion has just been made. Europe's premier metallurgical country, like other industrial countries, has had its succession of good years of which the present is a very satisfactory development.

Big Increase in Pig Iron Output

Nothing indicates more clearly the solid basis on which the German iron industry rests than the returns of production of crude iron which show a most remarkable increase between the years, say, 1905-1912. One of the red letter years of the German iron industry was 1907; but that was surpassed by 1910, which in its turn was surpassed by 1911. And when we take into account that the production of crude iron this year for the first nine months aggregated 12,859,375 tons and that the production in September alone totalled 1,479,285 tons, it is very clear that as nothing of a disastrous nature has occurred to the industry up to date, the year 1912 is going to far surpass all predecessors in respect to production.

Prices Have Advanced

While production has been so satisfactory, prices also have corresponded largely to the demand. Of course the maker does not always get the whole increase in the price, but has frequently to share it largely with his workmen, and no doubt when accounts come to be made up for 1912, it will be seen that a good deal of the apparent profits was tapped on the way by the laborer. The demand at the moment remains good and the same note will probably apply to every period of the year as it has come round. It has been the rule in Germany, as in neighboring countries, to require long periods of delivery, and to exact premiums for advancing the date of such delivery. There is, it is said, a slight slackness in the market not so much in point of genuine demand, but rather in the form of nervousness on the part of large export houses, which are careful about committing themselves even on behalf of good clients so long as there is any threat of the Balkan troubles extending and becoming the direct affair of the great powers.

The rise in prices that has taken place in the course of the year does not appear to have made any difference to the demand. Makers have their books full of orders at the highest prices. The bar iron market, like the rest, is firm and the makers are well booked up. The price is maintained at 125 marks ($29.37½) but, as suggested above, the tendency to go higher has been arrested by the political situation. Hot rolled bands are quoted at 142.50 to 145 marks ($33.68 to $34.07½) for parcels of 10 tons minimum. Foreigners are buying quite readily at the price of 148.50 marks ($34.84¼) f. o. b. at a North Sea port. Cold rolled bands are exceedingly strong and makers have good orders both for home and foreign consumption.

Political Uncertainty

The political outlook for the coming year is so uncertain that practically for all classes of metallurgical products higher prices are not asked. This is particularly the case with heavy goods. The plate market is strong and producers have orders up to February next year. They will have difficulty in being punctual even after allowing themselves plenty of time. Ship plates, too, are sold easily for home and foreign use; but they have not fluctuated very materially during the past few months. They are quoted 132.50 to 135 marks ($31.-13¾ to $31.72½) for home and practically the same prices rule for ex-

port. Sheets are in good demand for home account and are quoted between 142.50 and 147.50 marks ($33.-48¾ to $34.66¼). Practically the same note applies to gas and steam pipes which have profited by an agreement among the makers and good prices rule for these goods. The same is to be said of rolled wire and the works in the union are well employed. In the drawn wire business, there are plenty of orders; but here in contra-distinction to other departments of the metallurgical industry, there are complaints about prices. Drawn wire costs 14.25 marks ($3.34½) per 100 kilogrammes and it can be easily inferred from the foregoing, which refers particularly to the state of affairs in the Rheinland-Westphalian iron district, that machinery and boiler makers have engagements lasting them for a long time and at satisfactory prices. If there is a solid complaint anywhere on account of a decline in trade, it can only be found among the producers of small goods to whom the Balkan States now at war were good customers, and of course these markets, except for military requirements, are now closed. There is a terrible shortage of wagonage which goes a long way to strangling a good deal of activity in iron circles, and it is said on behalf of the large producers that the administration should once for all take measures in providing extra requirements in wagons and have them built in time for a period of boom such as the present.

Iron Ore Supply

Other iron producing districts of Germany send in similar reports on the top of a year's extreme prosperity, and to speak of them in detail would be practically to repeat the language used about the Rheinland-Westphalian district. One of the developments of the year has been the acquisition of iron ore mines in Sweden. A number of the German works, either because of quality or distance, find they are compelled to go out of the country and import iron ore per ship. Decisive steps in this direction have been taken by the acquisition of extensive iron ore fields in Sweden and elsewhere. It is well known that German iron masters have acquired considerable interests in the iron ore deposits of Normandy and of course the efforts they make to supply this from the Spanish iron fields are well known.

In respect to the supply of raw material at home, it was stated some time ago that in connection with the formation of a new ironstone mining company it was proposed to reduce the production of ironstone in the country to some kind of uniformity, as hitherto the producing elements were too independent and were not in sufficiently strong hands, one idea being to render the German pig iron smelters more independent of foreign supplies. The proposition has awakened great interest in circles directly affected, and it is hoped that the meetings called to consider it will result in something effective being done to bring the whole resources in iron ore into more direct relations with the furnaces, and make the importation of ore from abroad more a matter of supplementary facilities than a prime necessity, which it largely is today.

The progress in the German iron trade from the beginning to the end of the year has been so uniformly favorable and the signs for the future, always putting aside the possibility of political complications, are the most encouraging conceivable.

New Building for Geological Survey

In his thirty-third annual report Geo. Otis Smith, director of the United States geological survey, makes an earnest plea to congress for a new building to replace the old and inadequate rented building in which the survey is now housed. The survey has an annual appropriation of more than $1,500,000 for carrying on geologic, topographic, hydrographic and other scientific investigations, but Director Smith remarks that the handicap which the organization suffers in being crowded into an inadequate, badly-lighted, unsanitary and unsafe building much too small for its absolute needs is a limitation on economy and efficiency in administration.

Referring to the fire risk the director estimates the money value of the records necessarily stored in the survey building at $4,840,000, and this value represents largely the amount that would necessarily be expended in duplicating the unpublished material and in replacing the large stock of map plates which could be re-engraved from published maps. But there is a sense in which the loss in official records can not be estimated in dollars. The detailed stream-gaging records for 20 years could not be replaced except by another 20 years of observations, and similarly, unpubished geologic data contained in note books and plats and represented by the working collections of specimens could hardly be replaced, except in an equal length of time. The land-classification work of the survey is now proving how invaluable are these unpublished data, accumulated during the last 33 years, and a destructive fire in the wing of the building occupied by the land-classification board would destroy records whose loss would long delay the issuing of land patents throughout the public-land states. During the last nine years there have been four fires in the survey building.

For 27 years the matter of a new building for the geological survey has been before congress, and many favorable committee recommendations have been made. The latest action was taken in 1910, when congress directed the preparation of designs and estimates for a building for the geological survey and other bureaus of the interior department, designating a tract of government land on which the proposed building should be erected.

On May 20, 1911, the secretary of the treasury transmitted to the house of representatives sketches of such a building, with five preliminary estimates of cost, ranging from $1,950,000 for a three-story brick building to $4,900,000 for a seven-story stone building. The larger amount is approximately the same as the replacement value of the public property that would be safeguarded by the erection of such a building and that is now exposed to the considerable fire risk in the survey's present quarters. The act authorizing these estimates specifies "fireproof building of modern office building type of architecture." Action on this report has not yet been taken by the house committee on public buildings.

General Electric Pension

The General Electric Co., Schenectady, N. Y., has announced a comprehensive pension plan which will provide for all male employes who have been in the service of the company 20 years and have reached the age of 70, and for female employes who have been in the employ of the company the same number of years and have reached the age of 60. Male employes may be pensioned if incapacitated for work at the age of 65; female employes at 55. The pension consists of 1 per cent of the average yearly wage for the 10 years preceding retirement, multiplied by the number of years employed, the limit being $125 per month.

Electrical Equipment of Modern Mill Cranes

Development of the Dynamic Braking Hoist Controller and Its Application to Cranes, With a Discussion of the Economies Effected

By H F Stratton[1]

LESS THAN 25 years ago, Lord Armstrong, inventor of the hydraulic crane and Armstrong ordnance gun, said he "felt satisfied in point of safety, controlability and adaptability to various purposes, that electricity had little chance of ever rising to the level of hydraulic power." Probably these very qualities which formed the basis of Lord Armstrong's indictment of electric power, have been the strongest reasons for its extensive use in the steel industry, and particularly in connection with mill cranes. Each succeeding year, it has been demanded that electric cranes operating in mills handle heavier loads, and do so with greater speeds, while preserving the same reliability and ease of control. Motors of larger horsepower have been required, and on nearly all new equipments, the mill type motor is now specified, with its excellent commutating qualities and sturdy mechanical design. The use of increasingly large motors, and the extra duty thrown on the mechanical lowering brake by the hard service, have led to radical changes in crane controllers, and, in fact, the electric controller as applied to a mill crane today is entirely different from its predecessor of only two years.

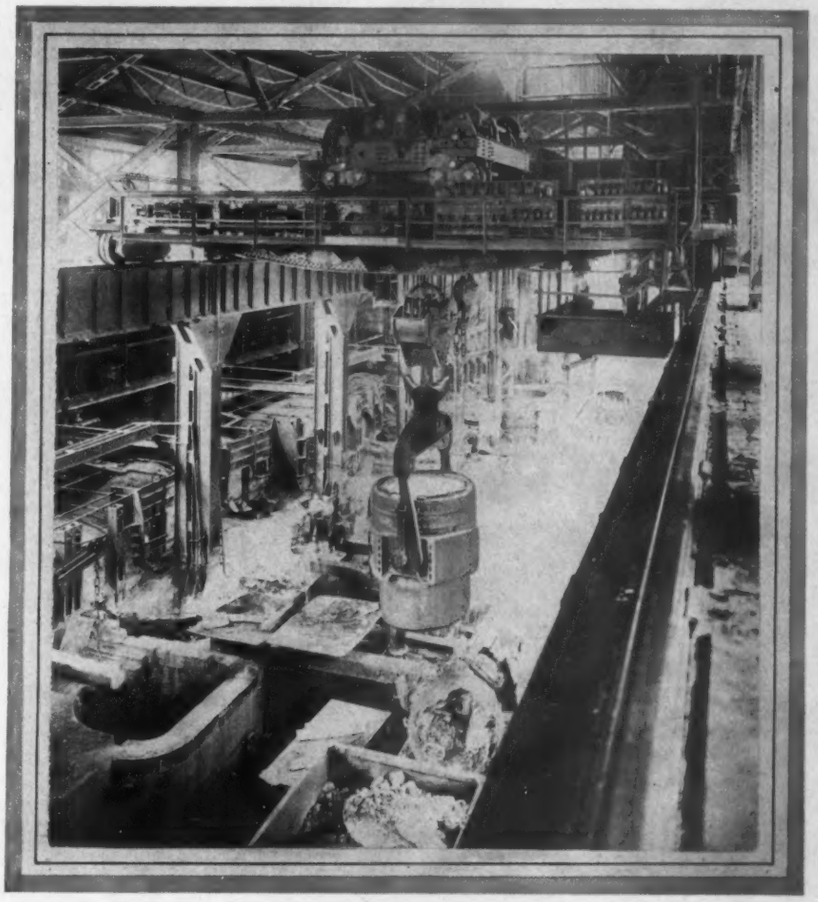

FIG. 1—LARGE LADLE CRANE WITH COMPLETE MAGNETIC SWITCH CONTROL EQUIPMENT. THE SWITCHBOARDS AND RESISTANCE ARE MOUNTED ON THE BRIDGE GIRDER

Entirely aside from considerations of operating economy, or convenience, many new features of design have been developed in response to demands from the large steel companies that safety devices be installed. It is certainly true that the iron and steel industry has spent large sums of money liberally for appliances designed to prevent accidents in the mills, and a good proportion of such safety appliances has been installed on cranes.

During the last two or three years, a most important development in the control of hoist motors has been the perfection, and the present almost exclusive use, of what is termed the *dynamic braking hoist controller*. In this system of control, the speed of the motor during the hoisting period is regulated in the usual manner by the insertion of an adjustable amount of resistance in series with the motor, but during lowering, the connections are changed entirely, and the load is either driven down by power if it is not sufficient to overhaul the motor, or, if it has a sufficient overhauling tendency, the motor is actually converted into a generator, returning power to the line.

That the advantages of this system of control may be properly understood, it would be well to review what actually occurs when a load is lowered through a mechanical lowering brake in connection with a plain reversing controller. When a crane is lifting a load, electrical energy must be supplied to the motor of an amount equivalent to the sum of the work performed in elevating the load against the force of gravity, the various frictional losses in the gearing and other parts of the hoisting mechanism, and the frictional, magnetic, and electrical losses in the motor. The only useful work is, of course, the lifting of the load, which is the product of the vertical distance through which the load travels and its weight in pounds, this quantity being expressed in foot-pounds. The useful work performed in lifting the load remains the same as long as the weight of the load and the distance through which it is hoisted are fixed, and is entirely independent of the speed of hoisting. When the same load is lowered the same distance, exactly the same number of foot-pounds are available for doing work as were consumed in elevating the load. As an illustration, if 10,000 pounds are lifted 20 feet, this has called for an expenditure of 200,000 foot-pounds of work, and this same 200,000 foot-pounds are not only available, but somehow *must* be dissipated

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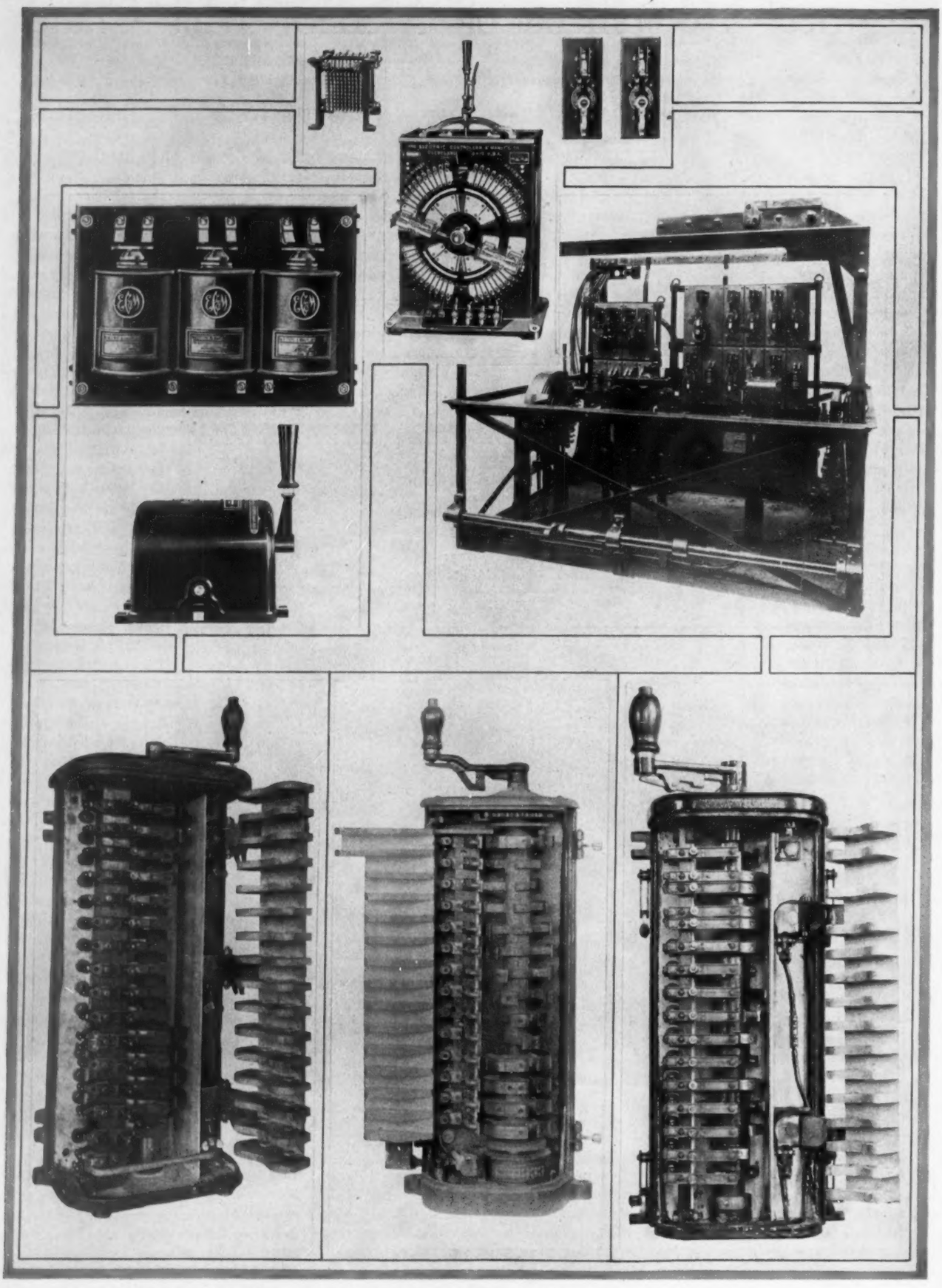


FIG. 2—CRANE CONTROLLER WITH ACCELERATING UNIT AND OPERATOR'S SWITCH

FIG. 3 — DYNAMIC BRAKING CONTROLLER

FIG. 4—CAGE OF A STEEL FOUNDRY CRANE

FIG. 5—THREE DIFFERENT MAKES OF DRUM TYPE, DYNAMIC BRAKING, HOIST CONTROLLERS

during the process of lowering. In hoisting, the friction losses of the machinery must, of course, be added to the work which must be supplied to the hoisting mechanism, whereas in lowering, this same friction has a restraining effect, and, to a certain extent, retards the lowering of the load in response to the force of gravity. If, for instance, the friction of the machinery is 25 per cent, 250,000 foot-pounds would be required to lift the load through the distance mentioned, and, in some manner, 150,000 foot-pounds of work must be dissipated during the equivalent lowering process. Where a load is lowered through a mechanical brake, or through any other kind of friction brake, this 150,000 foot-pounds—to follow out the same illustration—is converted into heat in the brake, and must be carried away by the circulation of air, or by conduction to other parts of the crane trolley. The mechanical lowering brake must, therefore, be looked upon as an appliance which *must* generate heat during the lowering of the load, and if the brake is not to become dangerously hot, it must rapidly dissipate this large amount of heat.

The conversion into heat, of the work of lowering loads of weights which are commonly handled, and at common speeds, is no insignificant item, as will be readily apparent from the following illustration: A crane handling a 5,000-pound lifting magnet 20 feet twice a minute for a period of half an hour, would generate enough heat in the mechanical lowering brake, through the process of lowering this magnet, to melt 15 to 20 pounds of cast iron if none of the heat were dissipated by the brake.

Another illustration—probably extreme but startling—of the amount of heat generated by lowering a load, recently came to the writer's attention in connection with the erecting cranes used for building the new Quebec bridge spanning the St. Lawrence river. On these cranes, it will sometimes be required to lower a load of 50 tons through a distance of 300 feet. During the operation of lowering this load once, sufficient heat would be generated in any type of friction lowering brake, to melt 100 pounds of iron.

The net result has been that any type of mechanical or friction lowering brake is very apt, even in moderately hard service, to become so hot that the depreciation and maintenance charges are excessive, and some figures actually gleaned from mill experience will be given below which will certainly verify this statement.

The dynamic braking hoisting controller owes its major economy to the fact that, by its use, the mechanical brake is dispensed with entirely, and the retarding effect during lowering is secured by converting the motor into a generator and thereby securing a retarding torque, and at the same time returning useful work to the supply lines.

The system of control is such that if the load is not sufficient to overhaul the motor, it automatically and immediately becomes a generator in its action, and retards the speed of lowering to a degree which may be adjusted readily through wide limits by the insertion or removal of resistance. The main point which it is desired to emphasize is that instead of transforming the work of lowering the load into heat in some type of friction brake, this same work is transformed into useful electrical en-

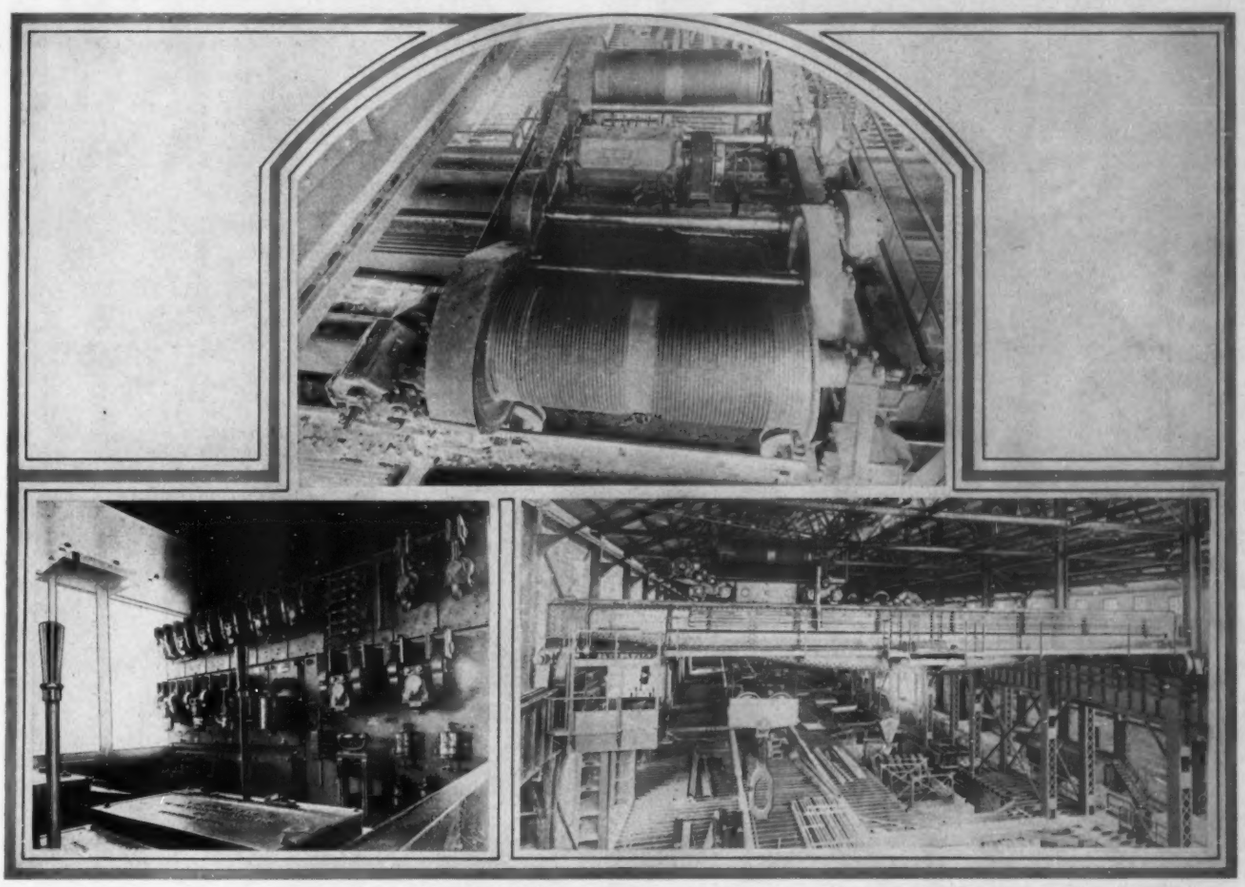


FIG. 6—MAIN TROLLEY OF CRANE SHOWN IN FIG. 8

FIG. 7—DETAIL VIEW OF INTERIOR OF CAB OF LADLE CRANE, FIG. 8

FIG. 8—LADLE CRANE WITH LARGE CAGE TO ACCOMMODATE MAGNETIC SWITCH CONTROLLERS AND CRANE SWITCHBOARD

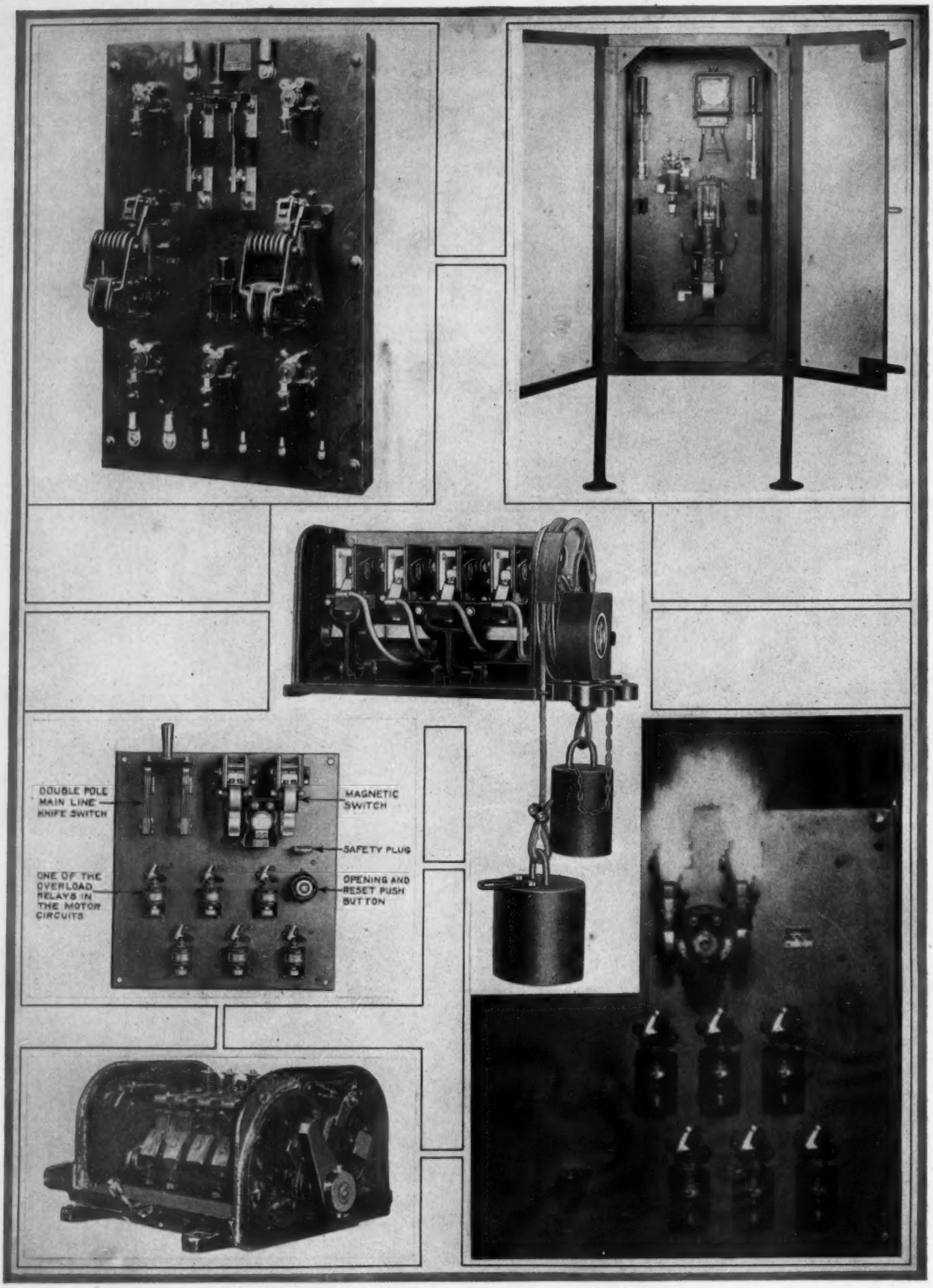

DOUBLE POLE MAIN LINE KNIFE SWITCH
MAGNETIC SWITCH
SAFETY PLUG
ONE OF THE OVERLOAD RELAYS IN THE MOTOR CIRCUITS
OPENING AND RESET PUSH BUTTON

FIG. 9—SWITCHBOARD FOR THREE-MOTOR CRANE

FIG. 10—CRANE RUNWAY FEEDER PANEL

FIG. 11—CRANE LIMIT STOP WITH COVER REMOVED

FIG. 12—CRANE SWITCHBOARD, WITH EXPLANATION OF VARIOUS PARTS

FIG. 13—CRANE LIMIT STOP WITH LEVER REMOVED

FIG. 14 — CRANE SWITCHBOARD BREAKING HEAVY OVERLOAD

ergy, or, at the worst, a portion of it appears in the form of heat in cast grid resistance which is designed for the specific purpost of dissipating heat rapidly and without deterioration.

In regard to actual maintenance charges on friction lowering brakes, the following figures relating to two mill cranes, are illuminating: A 5-ton crane handling sheets from a pickler to a tinning machine in a tin plate mill, required repairs on the friction lowering brake amounting to $746.40 in one year. On a stripper hoist in the same steel plant, it cost $1,463.80 to maintain the friction brake for a period of one year. Eighteen months ago, each of these cranes was equipped with a dynamic braking controller and the cost records show that there have been no renewals of any friction members and that no other charges have increased. In short, these dynamic braking installations represent actual savings of $746.40 and $1,463.80, respectively. At the October 1912, meeting of Association of Iron and Steel Electrical Engineers, O. R. Jones, electrical superintendent of the Youngstown Sheet & Tube Co., Youngstown, O., made the following statement: "We find that the cost of maintaining mechanical brakes amounts to about one-half of our total maintenance charges on cranes, and we are replacing them as fast as possible."

Comparative Results

With the idea in mind of securing accurate comparative results, a careful series of tests was recently made on two mill cranes almost identical except that one was equipped with a mechanical lowering brake and a plain reversing controller, while the other was equipped with a dynamic braking controller. Each controller had the same number of steps and all adjustments on the controllers were made as nearly identical as possible. A recording ammeter registered the current input to the motor and another electrical recording instrument was so arranged that it registered the motor speeds at all times. Tests were run on each crane with an empty hook, with a 4,200-pound load and with an 18,400-pound load. Curves 1, 2 and 3, Fig. 28, relate to the crane with mechanical lowering brake and reversing controller, while Curves 4, 5 and 6 refer to the crane equipped with the dynamic braking controller. All these charts were recorded and deduced for merely the lowering operation since the processes of hoisting would be the same in each case. Comparing Curves 1 and 4, it will be noted that the maximum speed attained on the crane with the mechanical brake was 325 per cent of normal full load speed; in fact, this lowering speed is limited only by the more or less haphazard friction of the crane, since with no load, a series-wound motor will theoretically reach an infinite speed and practically will accelerate to a velocity so high that the armature will burst or *fan*. On the crane with the dynamic braking controller, the maximum speed is 240 per cent of normal full-load speed and, although the friction of the crane influences this result, yet the determining factor is the retarding effect of the motor. Even if the friction were

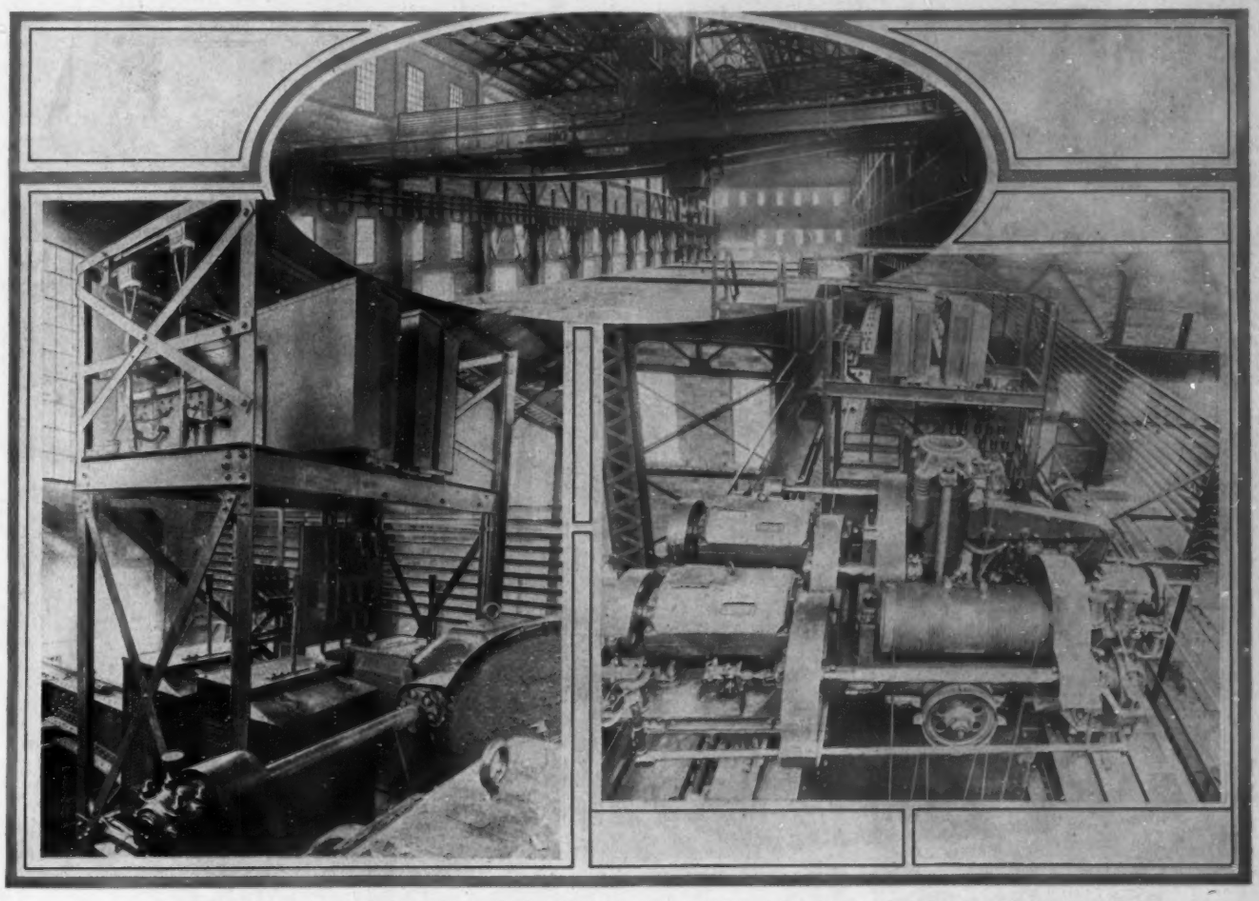


FIG. 15—SOAKING PIT CRANE INSTALLED IN THE PLANT OF THE MINNESOTA STEEL CO.

FIG. 16—CAGE OF THE SOAKING PIT CRANE, FIG. 15, WHICH CONTAINS SWITCHBOARD, CONTROLLERS, ETC., CONVENIENTLY ARRANGED FOR OPERATION

FIG. 17—CONTROLLER AND DOUBLE-DECK CAGE OF SOAKING PIT CRANE, MAGNETIC SWITCHBOARD AND MANUAL CONTROLLERS ON UPPER DECK

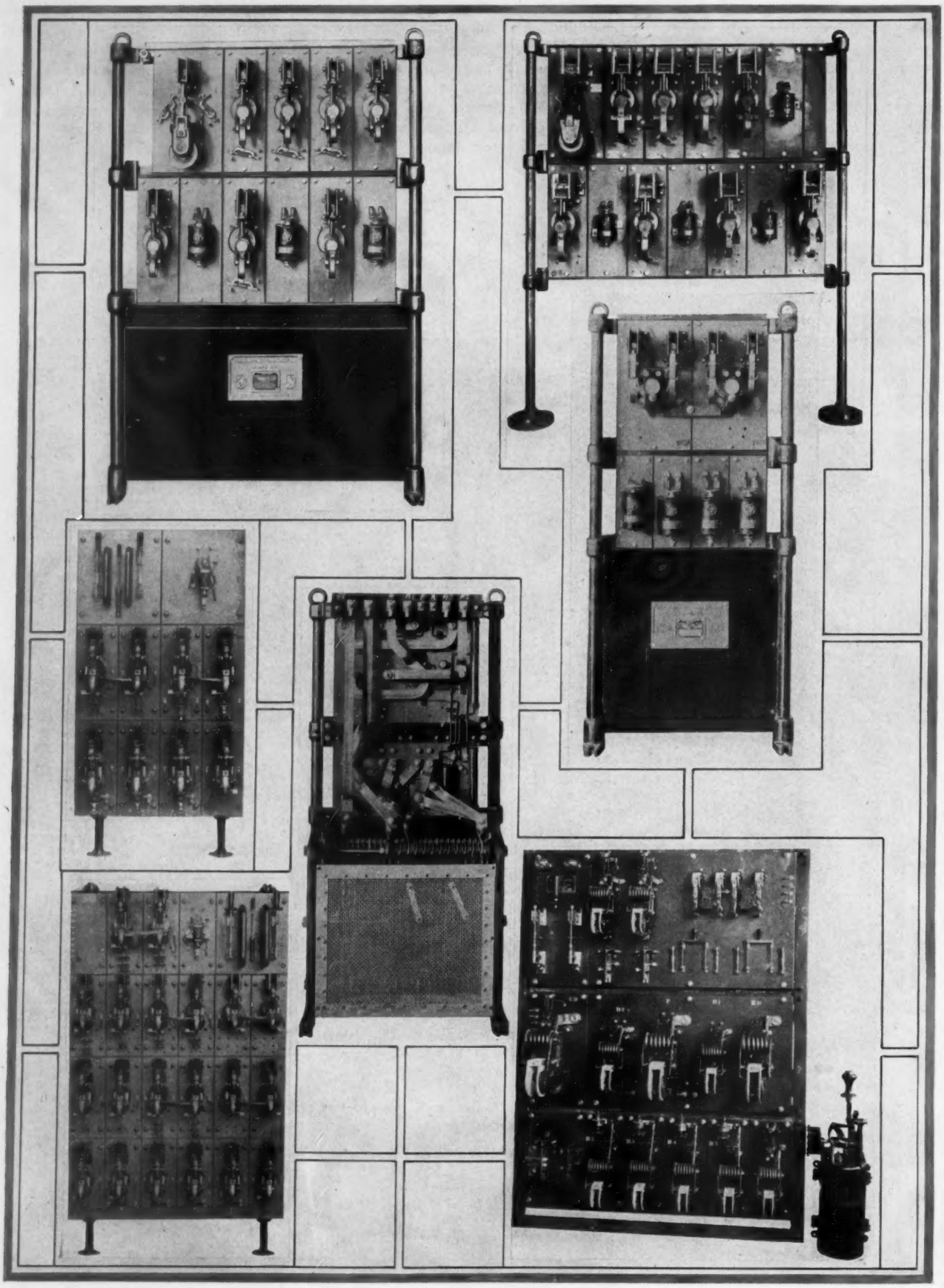


FIG. 18—100-HORSEPOWER, MAGNETIC SWITCH DYNAMIC BRAKING HOIST CONTROLLER, WITH SELF-CONTAINED RESISTANCE

FIG. 19—MAGNETIC SWITCH, DYNAMIC BRAKING, CONTROLLER WITH SEPARATE RESISTANCE

FIG. 20—MAGNETIC SWITCH REVERSING CONTROLLER

FIG. 21—REAR VIEW OF CONTROLLER, FIG. 22

FIG. 22 — REVERSING MAGNETIC SWITCH CONTROLLER WITH SELF-CONTAINED RESISTANCE

FIG. 23—LARGE MAGNETIC SWITCH SERIES PARALLEL REVERSING CONTROLLER

FIG. 24—LARGE MAGNETIC SWITCH, DYNAMIC BRAKING, HOIST CONTROLLER

nil, the resistance of the controller could be so balanced that the maximum lowering speed would be within practically any limit specified, even less than full load speed if that were desired. As to the current input for the cranes equipped with a mechanical brake, and with dynamic braking, these are illustrated by Curves 2 and 5, respectively.

Curves 3 and 6, Fig. 28, indicate the maximum lowering speeds and the horsepower input for various loads from empty hook up to 10 tons. In the case of the crane with the mechanical brake, the horsepower input ranges from 14 to 8 (normal for the motor is about 25) and would have continued at about 8 up to and surpassing the full load rating of the crane. Curve 6 reveals that on the crane with the dynamic braking controller the horsepower input drops from a maximum of 14 to a minimum of 1 and commencing at loads slightly greater than 20,000 pounds, there would have been an increasing net return of power to the supply lines.

Curves 7 and 8, Fig. 28, are particularly interesting and instructive as indicating, respectively, the normal step-by-step lowering speeds for various loads on the crane with the mechanical brake and on that with the dynamic braking controller. Referring to Curve 7, the motor starts on the first step of the controller and at once attains a speed of 55 per cent of normal. Due to the jamming of the mechanical brake at heavier loads, the motor will not start on the first point of the controller with loads of 4,200 pounds and 18,400 pounds. When it does move on the second controller step, the speed jumps up at once to 115 per cent normal speed in one case and 180 per cent normal speed in the other case. As to the crane with dynamic braking, the results of which are depicted in Curve 8, the motor starts in every case on the first controller step and reaches speeds which vary from 10 to 35 per cent of normal. The importance of this comparison is the superior control of slow lowering speeds obtained by dynamic braking.

It must be borne in mind, that the retarding effect of the dynamic braking action, as applied to a lowering load, exists practically, only while the armature is rotating, although, as a matter of interest, it might be stated that dynamic braking actually persists for a brief period after the motor has come to rest, due to inductive effects. Therefore, while we may look, with great assurance to dynamic braking to retard a lowering load, we must provide entirely separate means to actually hold the load stationary. For this purpose, a magnetic brake is placed on the armature shaft to lock the motor when the controller is brought to the *off* position. In the case of hot metal cranes, where accident would be perilous to human life and expensive, the recommended and usually-adopted practice, is to mount an additional magnetic brake as close to the cable drum as possible. This supplementary brake provides a secondary line of defense, so to speak, and would hold the load should the gears become loose on their shafts or should the teeth of the motor pinion become stripped. In short, on any crane equipped with a dynamic braking controller, the magnetic brake should be of good design and of ample capacity to hold any load which may be hung on the crane hook. As a contribution to safety of operation, electrical devices have been developed and applied to dynamic braking control, so that even in the event of the simultaneous failure of the magnetic brake, the supply voltage and the control wiring, the worst eventuality which could occur, would be the extremely slow lowering of the load. This lowering would actually happen at a speed so slow that, generally speaking, it would require several minutes for the load to reach its bottom limit. A car dumper with dynamic braking was purposely lowered through this emergency feature and 10 minutes were consumed in the period of dropping.

Of importance, second only to the introduction of dynamic braking, is

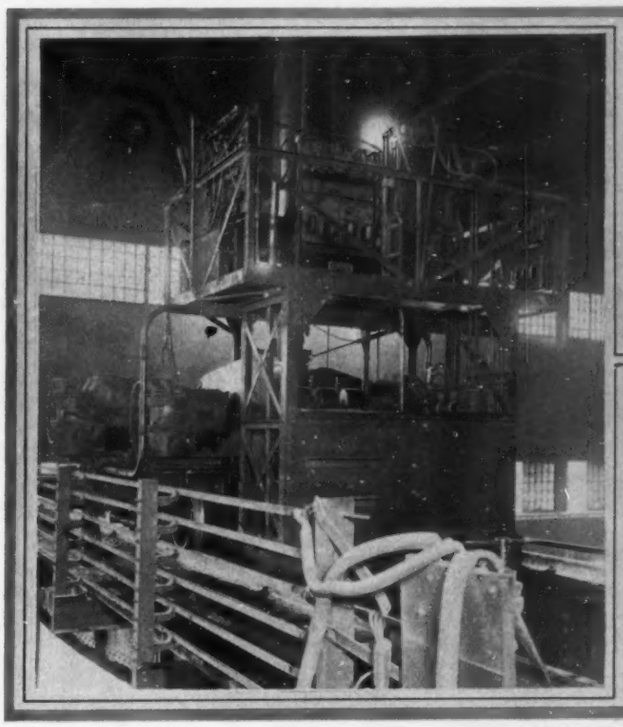


FIG. 25—A WELL-DESIGNED DOUBLE-DECK CRANE CAGE IN WHICH THE CONTROLLING APPARATUS AND SWITCHBOARD ARE LOCATED

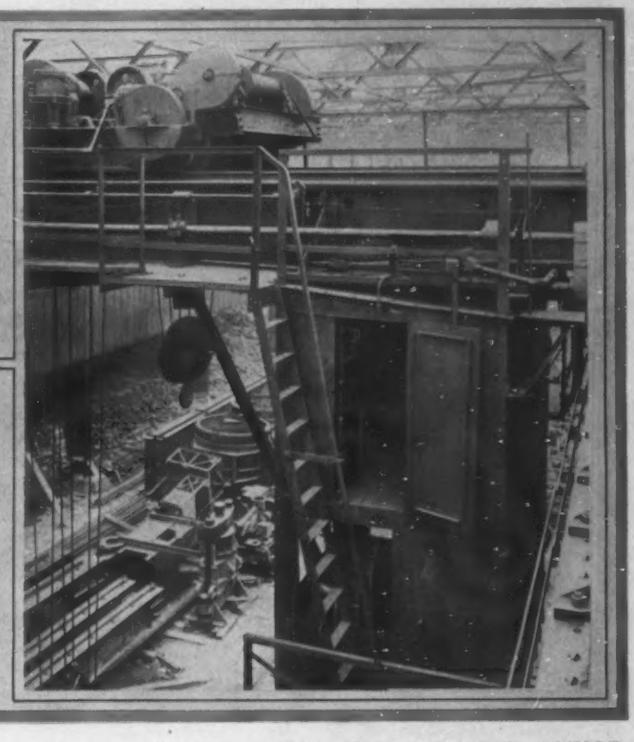


FIG. 26—OUTDOOR CRANE WITH ENCLOSED DOUBLE-DECK CAGE SWITCHBOARDS MOUNTED IN TOP ROOM AND MASTER SWITCHES BELOW

the application of automatic magnetic switch controllers to mill cranes. The use of magnetic switch controllers was forced several years ago by the constantly increasing size of motors which were being specified, it being found that it was fatiguing to the craneman and expensive in maintenance, to control, for instance, a 100-horsepower motor installed on a crane which was operated with considerable frequency. The leading advantages of automatic magnetic switch control may be briefly summarized as follows:

(1)—Limitation of current input to motor, reducing burn-outs and commutation troubles.

(2)—Limitation of torque in all parts of the machinery including the motor, because of the limitation of current.

(3)—The ability to open circuits carrying large currents without the heavy depreciation that would result on a manually-operated controller with sliding contacts.

(4)—The gain in time due to accelerating or reversing the motor in the shortest safe time.

(5)—The greatly increased convenience and dexterity given the craneman in the operation of a small master switch.

It should be borne in mind that the manufacture of steel is essentially a series process where the impairment of any one step may make idle an amount of equipment which is appalling. It must also be remembered that this is an industry, the very statistics of which are dramatic, and that the monetary loss due to the failure of any vital part of the equipment, may total thousands of dollars, in minutes. So it is not surprising that the demand for automatic magnetic switch control became insistent when it was evident that such control reduced delays.

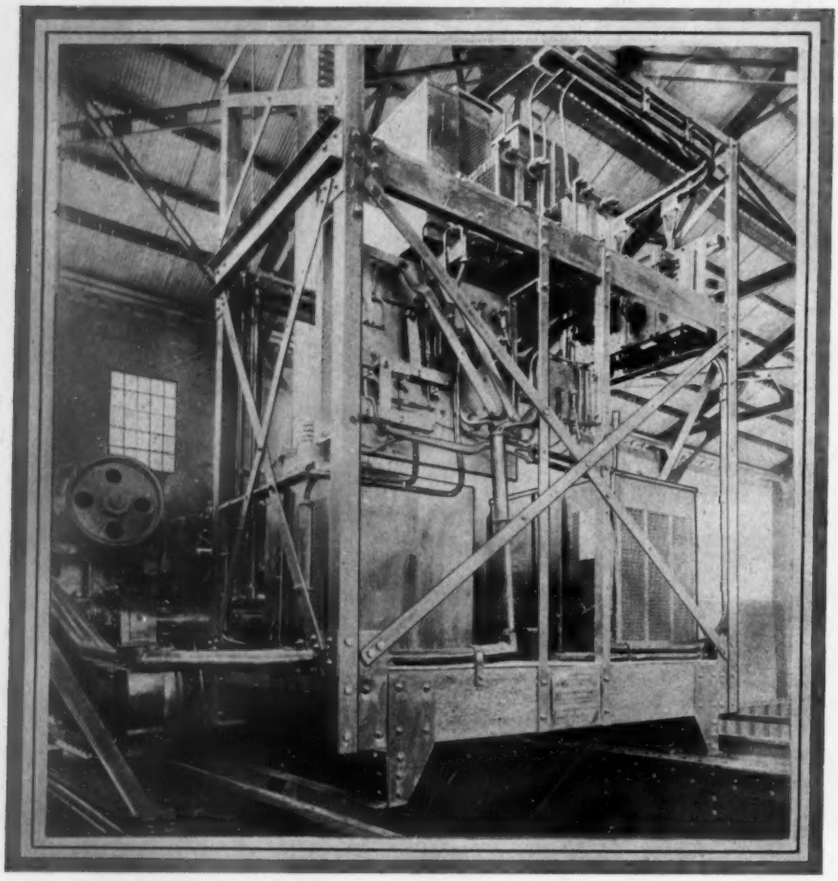


FIG. 27—DOUBLE-DECK CAGE ON SOAKING PIT CRANE

The one feature which proved to be the barrier to its wider use, was its complication. Until recently, a magnetic switch controller involved a large number of fine wire coils, small control wiring, and a mass of auxiliary control contacts. The protection to the machinery was obtained, but the controller itself became the object of frequent and expensive attention. Through natural development leading to simplification, the magnetic switch controller has been constantly made more sturdy and reliable, but the feature which more than all else, has accelerated its use, is the introduction of the series operated magnetic switch. This switch has, in place of the fine wire shunt coil, a heavy wire or strap coil of few turns in series with the motor itself. The series switch has the remarkable characteristic of locking open when the current exceeds a certain value and of closing only when the current flowing through the motor has dropped to this value, due to the acceleration of the motor. The series switch, at one step, replaces a shunt-operated switch with its fine wire coil, an accelerating relay and more or less of intricate control circuits and control contacts. With this simplification and cheapening of the equipment, magnetic switch controllers were rapidly applied to all kinds of cranes and instead of finding magnetic switch controllers for merely the very large motors, we now see them, in many cases, used on every motion of the crane, even 3½-horsepower and 5-horsepower trolley motors.

Largest Recent Installation

One of the largest recent crane installations, was that made by the Youngstown Sheet & Tube Co., and here every motor, ranging from the small trolley motors up to the hoist motors of large ladle cranes, was equipped with magnetic switch control. It can be stated without fear of contradiction that nearly all new mill cranes are being ordered with magnetic switch control throughout, or with magnetic switch controllers for all motors larger in size than 25-horsepower, While it is true that the use of the series-wound switch is not suitable for the dynamic braking hoist controller, because of the greater complication of the circuit changes, yet even this controller is being largely specified of the magnetic switch type for the sake of uniformity of equipment and to secure the advantages peculiar to the magnetic switch controller. To summarize, the motors on mill cranes, like the motors in almost every industry, show the rapid replacement of manual control by automatic control.

The Crane Switchboard

The crane switchboard had its inception, several years ago, in the discussion and recommended design of the Association of Iron and Steel Electrical Engineers, and its wide adoption has been due largely to the safety features which it provides. It is made up generally of a circuit

breaker switch for disconnecting from the supply lines all the motors on the crane, overload relays for each motor circuit, push buttons for closing or quickly opening the circuit breaker switch, and a safety plug, the removal of which makes it impossible to close the circuit breaker switch and thereby makes all the crane motors inoperative. In case of sudden danger, every motor on the crane can be stopped instantly by pushing the opening button and by this action, disconnecting the motors from their supply of power. As to the safety plug, this is intended to be removed and a lock placed in front of its socket, by any man repairing or working on the crane, who thus insures that the crane shall not be moved until he has finished his work and has removed his lock and reinserted the safety plug. The circuit breaker switch, in connection with relays, also provides overload protection and stops the expensive practice of blowing fuses, not an inconsiderable item in the case of 500-ampere enclosed fuses.

Extensive Application to Mill Cranes

The extensive application of magnetic switch controllers and crane switchboards to the modern mill crane, calls for an amount of space in the cab, which sometimes necessitates its enlargement. This is frequently provided by making it of double-deck construction, mounting the switchboards and resistance on the upper deck and assembling merely the master switches on the lower deck. An interesting grouping is shown in Fig. 1, where the switchboards and resistance are mounted on the bridge girders along practically the entire length of one side of the bridge.

Crane Hoist Limit Stop

No description of the electrical devices on a mill crane would be complete without a reference to limit stops designed to prevent over-travel of the hook block. The trend of development of such limit stops shows that they are generally operated directly by the hook block itself instead of being geared to the hoisting machinery, and that they forcibly stop the motor by dynamic braking, instead of merely disconnecting the hoist motor from its source of power. Both of these features of operation are warranted by the results obtained, for they lead to absolute sureness of operation and extremely accurate stopping.

While the title of this article might properly include the subjects of motor design and alternating current apparatus, both of these topics are so large in their scope, as to warrant individual discussion.

A Combination, Steel-Making Furnace

A combination furnace has been patented by Fred B. Lamb, Bettendorf, Ia., in which the object is to utilize the best features of the open-hearth furnace, Bessemer converter and electric furnace. The Bessemer converter is recognized as an excellent means of deoxidizing and desiliconizing; the basic open-hearth furnace excels in dephosphorizing; the electric furnace has its advantages in the removal of sulphur and as a deoxidizer. A combination of these features in a single tilting, open-hearth furnace with converter and electric attachments is proposed by the inventor.

The furnace consists of the usual tilting structure and the gas ports are provided with vertically-movable gates, which can be lowered and raised from the outside. The charging port is normally kept closed by a door. The Bessemer converter consists of a chamber, air box and air passages. At this part of the furnace, an air flue also is provided and extending down through the roof of the furnace are vertical, adjustable electrodes. When operating, the furnace is charged with about 15 tons of pig iron. With a high carbon content in the pig iron, oxidation commences immediately and the entire charge is melted in about two hours. When about five tons of metal have accumulated in the bath and after the blast has been turned into the converter, the furnace is tilted toward the blast end. This part of the metal is then decarbonized and desiliconized, its temperature being raised from 1,800 to 3,000 degrees Fahr. The highly acid slag which has formed can be poured off, this operation being facilitated by directing a blast of air through the flue. The furnace then is tilted back to a horizontal position. Because of the increased temperature of the five tons of metal which have been Bessemerized, and its impregnation with oxidizing gases, the reduction of the unmelted portion of the bath is hastened and its carbon is oxidized. During this operation, dephosphorization is continued steadily and in about two hours the entire charge is melted and its carbon, silicon and phosphorus are reduced.

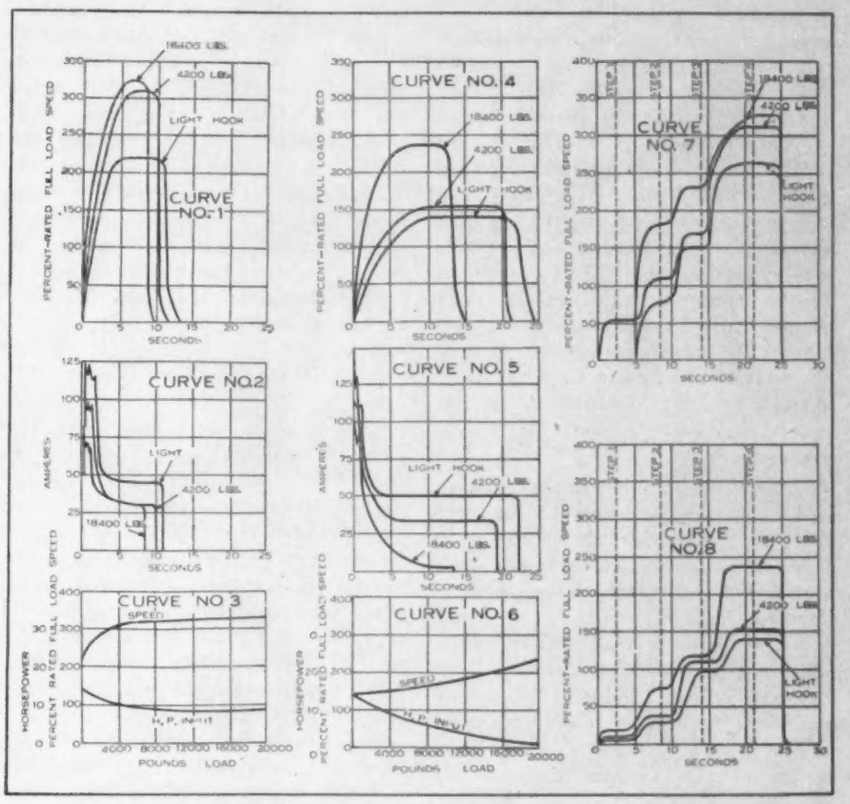


FIG. 28—CURVES WHICH GRAPHICALLY SHOW RESULTS OF TESTS ON TWO MILL CRANES, ONE EQUIPPED WITH MECHANICAL LOWERING BRAKE AND PLAIN REVERSING CONTROLLER, WHILE THE OTHER WAS EQUIPPED WITH DYNAMIC BRAKING CONTROLLER

Year of Tremendous Activity in Chicago District

Mills Overwhelmed With Orders and Deliveries Far Extended—
Greater Prosperity Than Ever Before Enjoyed—Splendid Outlook

By E R Boyer

AT THE opening of the year 1912, the steel industry in the west faced a brighter outlook than at any time during the past five years. During the last few months of 1911, the drastic price readjustments which had been in progress began to take effect, resulting in a rapid revival of orders in finished lines. This was led by very heavy car buying by western railroads, bringing into the market a large tonnage of plates and shapes, and was augmented by the elimination of uncertainties in regard to the freight rate controversy and trust cases. At the same time a heavy buying movement in southern pig iron developed, rallying the market and firmly establishing $10, Birmingham, as the ruling quotation at the close of the year. As a result of the steady market for finished lines, western makers were able to raise their prices $1 a ton and open their books for the new year with exceedingly bright prospects.

During the first week in January, it became very evident that a much more favorable showing would be made than during the previous year. Business in all lines throughout the country had returned to a sound economic basis and all artificial stimulus and untenable prices had been removed. Steel producers in general not only realized the advantages of the situation, but also were fully aware of the danger of advancing prices too rapidly. Early in the year, a little trepidation was felt concerning the effect of politics on business conditions. This, however, disappeared before the end of the first half. During the last half of the year, business continued at a rate that surprised even the most optimistic members of the trade and the necessary recurrence of favorable conditions after a long period of depression, without regard to political conditions, had been made obvious.

The first quarter of 1912 was productive of no price advances other than an appreciable stiffening on southern iron. Specifications in finished lines were maintained at their previous rate, but shipments exceeded new business and some apprehension was felt concerning the latter. During the latter part of January and February, the railroads were active buyers as indicated by the constantly increasing specifications for plates and structurals. New business continued light, however, which was to be expected, as it was thought to be inconceivable that the early January rate could be maintained. During this month, some producers reported a tonnage of new orders in excess of the total received during December, the latter month being considered above normal. As an indication of the degree of prosperity achieved during the year, the unusual tonnage booked during January has since been exceeded repeatedly, and during the last half of the year new records both for specifications and new business have been established.

First Quarter Developments

At the end of the first quarter, the Chicago furnaces were operating at but 33 per cent of their available capacity. Under these conditions, it was evident that great increases in the demand for pig iron must be made before any material advances in price could be established. During February, however, the Birmingham furnaces maintained their price of $10.50 everywhere except in the immediate vicinity of Chicago, where northern competition continued to make reductions necessary. At this time, considerable inquiry for third quarter began to appear, on which, however, the furnaces were not disposed to quote. Gradually the increases in business necessary to more advantageous quotations began to be felt. This was indicated by the run of specifications, melters taking out their full contract tonnage and in some cases asking the furnaces to anticipate deliveries. The situation in finished lines also improved perceptibly during the first quarter. Special activity was noted in plates and shapes, the demand for which was accelerated by a heavy run of fabricating orders and continued car buying by the railroads. During this period, rail buying was very light, and comparatively little new business was placed. The rail mill of the Indiana Steel Co. at Gary, was not started until the week of Feb. 29, at which time a fair accumulation of orders was on the books. During March, however, orders for about 130,000 tons of rails were taken by the western mills, and by the end of the first quarter the latter were operating on a fairly satisfactory basis, and were assuming a firmer attitude on the price of track fastenings, specifications for which had kept pace with the rail buying. It was not until the opening of the second quarter, however, that any appreciable price advances were established in finished lines.

At the beginning of April, some of the western mills found themselves with more business on their books than ever before in their history, and the newly advanced prices on bars, plates and shapes were maintained with little difficulty. On April 20, a second advance of $1.00 per ton was made, which was preceded by heavy contracting for future delivery, manufacturers regarding the time as propitious for covering for their requirements. As a result of this activity, the tonnages on mill books were largely increased and by the first of May a purely sellers' market existed for the first time in two years. Steel bars, which had been a weak spot in the market, participated in the advance, due to heavy buying during April by agricultural interests. During the month of May, delivery became a paramount consideration, and contrary to previous expectations, it became evident that the usual midsummer dullness would not materialize. By the last of May, both new business and specifications had increased to such an extent that the period for delivery had in some cases been extended until the middle of October. During this time, much contracting for delivery during the second half was done, and it became apparent that congested mill conditions would last throughout the summer. Specifications against contracts continued to increase throughout the second quarter of the year, the market exhibiting a marked upward tendency, and advances in all lines at the opening of the second half were practically assured.

During the entire first half of the

year, bar iron and wire products were weak in comparison with other lines. It was not until May that any appreciable hardening of the former was evident, when new prices were established at an advance of $2 a ton. At the close of the first half, wire nails were quoted at 1.78c, which was the price at the beginning of the year. The sheet market exhibited an equal lack of strength, the store price of No. 28 black being maintained at 2.30c until May, when an advance of $1 a ton was established. These apparent weaknesses, however, were quickly overcome during the third quarter. At the close of the year, bar iron, wire products and sheets were on a par with other materials.

Consistent with expectations, new prices were established on the first of July. While a large part of the consumption of the territory for second half had been covered during the latter part of the second quarter, some consumers had not as yet purchased their entire requirements and now found it necessary to meet the new prices. But little difficulty was experienced at this time in adjusting claims of buyers, specifications at the previous quotations either being canceled or carried over at the new prices. New business in steel bars was taken at 1.43c and plates and structurals were quoted at 1.48c. Bar iron shared in the advance, new quotations being $1 a ton higher than those maintained during May. New quotations were also established on wire at 1.83c.

In finished lines, the second half has been a repetition of the conditions which obtained during the second quarter. By the latter part of July, it was estimated that practically all the low price tonnage carried on mill books was cleaned up, and western producers were operating on business taken at figures that represented a good margin of profit. Specifications during the third quarter increased constantly, and in many cases were greatly in excess of shipments. By the first of August the mills were six months behind in delivery on bars, plates and shapes, and prices on these materials had advanced to 1.48c for the former, and 1.53c for the last two. Bar iron was also stronger and wire products had been advanced $1 a ton. Before the close of the third quarter, all indications pointed to an unfilled tonnage on the first of January larger than at any previous time in the history of the industry. For that reason mills refused to quote on 1913 business, although many consumers were disposed to make early contracts for delivery during the new year. Some of the leading western producers, including subsidiaries of the Corporation and prominent independents, were forced to take some 1913 business by the insistent demands of old customers. This, however, was scrutinized carefully, and the attitude of the mills was justified early in the last quarter by the certainty that the unfilled tonnage on Jan. 1 would exhaust mill capacities for the first quarter of the coming year, and would run well into the second quarter.

During the last month of the third quarter and the early part of the last quarter, subsidiaries of the Corporation began to take some new business for 1913 delivery. The independent producer followed the same course, but their first half capacity was quickly exhausted, and owing to the probability of an even larger unfilled tonnage on the first of next July, are at this writing refusing to entertain business for delivery during the last half of 1913. Prices on all finished lines have been advanced steadily until quotations obtaining during the last month of the year were on a basis of 1.45c, Pittsburgh, for steel bars and 1.50c for plates and shapes. All quotations on finished lines during the last quarter were largely nominal and prompt delivery had been practically an impossibility. While the books of some producers have been open for new business when the delivery was satisfactory to the buyer, very little has been placed, as it sometimes involves delivery little before January, 1914.

Railroad buying has been the most notable feature of the last half, due to the lesson experienced early in the year, when the railroads found it impossible to obtain deliveries. Rail buying for 1913 was very heavy and was accomplished at an early date. Rail purchases, however, have been exceeded by car buying, which has broken all previous records. During the past four or five years, railroad purchases of rolling stock have been light, and in consequence equipment has deteriorated to a point necessitating its early replacement. As a result, the western railroads found it necessary to place huge orders during the last half of the year, which in a great measure exhausted the plate and structural capacity of this territory. Railroad purchases of structural material for bridge work and building have been second only to car buying, further increasing mill congestion.

Fabricating orders have shown no deviation from the remainder of the market. Although the market for structural material was very active during the last part of the first half, the fabricators were unable to bring their prices up to a level consistent with mill prices. During the third quarter, however, this was accomplished with no diminution in structural contracts and business increased to such an extent that during the last three months of the year, it became impossible to place new business and many large projects were held up until 1913.

Although still falling slightly below the activity in finished lines, the pig iron market exhibited almost parallel conditions during the last half. Early in the third quarter, a buying movement developed in both northern and southern pig iron, resulting in an appreciable stiffening of prices. The market con-

Average Monthly Prices—Chicago Market 1912

Commodity.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Lake Superior charcoal, pig iron...	$16.50	$16.50	$16.50	$15.50	$15.75	$15.75	$16.25	$16.75	$17.75	$18.75	$18.75	$18.75
Northern No. 2 Foundry, pig iron..	14.00	14.00	14.00	14.00	14.50	14.50	15.00	15.50	16.00	17.25	18.00	18.00
Southern No. 2 Foundry, pig iron..	14.35	14.60	14.85	14.85	15.35	15.85	16.35	16.35	17.35	18.35	18.35	18.35
Bar iron, f. o. b. mill.....	1.15c	1.15c	1.15c	1.15c	1.25c	1.25c	1.35c	1.40c	1.45c	1.50c	1.55c	1.55c
Steel bars, f. o. b. mill.....	1.25c	1.30c	1.30c	1.33c	1.38c	1.38c	1.43c	1.48c	1.58c	1.63c	1.63c	1.63c
Structurals, f. o. b. mill.....	1.30c	1.28c	1.30c	1.38c	1.43c	1.43c	1.48c	1.53c	1.58c	1.63c	1.68c	1.68c
Plates, f. o. b. mill.....	1.30c	1.28c	1.35c	1.43c	1.43c	1.43c	1.48c	1.53c	1.58c	1.63c	1.68c	1.68c
Sheets, No. 28 black, store.....	2.30c	2.30c	2.30c	2.30c	2.35c	2.35c	2.45c	2.53c	2.70c	2.70c	2.70c	2.70c
Plain wire, jobbers' carloads.....	1.58c	1.58c	1.58c	1.58c	1.58c	1.58c	1.63c	1.68c	1.68c	1.68c	1.68c	1.68c
Wire nails, jobbers' carloads.....	1.78c	1.78c	1.78c	1.78c	1.78c	1.78c	1.83c	1.88c	1.88c	1.88c	1.88c	1.88c
No. 1 R. R. wrought, net ton.....	$11.25	$11.00	$11.50	$12.25	$11.75	$12.50	$12.00	$12.50	$13.00	$14.00	$13.25	$13.00
Heavy melting steel, gross ton.....	11.00	10.75	11.25	12.25	12.25	12.25	11.75	12.50	13.00	14.00	13.75	13.75
Rerolling rails, gross tons.....	13.00	13.00	12.75	12.75	13.25	13.50	13.25	13.50	14.75	16.00	16.50	16.50

tinued active on the whole through July, August and September, with the result that by the first of October, northern iron was firmly established on a basis of $17, f. o. b. Chicago, and southern iron on a basis of $14 Birmingham for delivery during the remainder of the year. During the last quarter, buying fell off somewhat, and southern iron for prompt delivery remains at the same level at the close of the year. Sales of northern, however, have been more active and prices have advanced to a firm basis of $18 f. o. b. furnaces.

At the beginning of the new year, the industry faces conditions incomparably better than those of a year ago, and is enjoying greater prosperity than at any previous time in its history. The mills of the Corporation have sufficient business on their books to run almost a year, and a like condition in independent mills is prevented only by their stand against second half business. The adverse features of the present conditions are found in the fact that many consumers are unable to cover for their requirements during the coming year, and in the danger of too great an advance of quotations, which is even more pronounced than it was at the beginning of 1912.

If a complete record of all of the new construction in the west during the year were published, it would require a volume larger than this issue of THE IRON TRADE REVIEW. In spite of this additional capacity, manufacturers find themselves at present unable to fill their orders without delays of greater or less consequence. It is evident, therefore, that there will be no decrease in new construction in western territory during the next half year. The principal plants erected during the past year include the following:

Blast Furnaces

Inland Steel Co., Chicago.—One 400-ton furnace known as the Madeline No. 2 was blown in at the Indiana Harbor plant in April. It is 90 feet high and 20½ feet in diameter at bosh. Described in THE IRON TRADE REVIEW, May 9, 1912, page 999.

Stephenson Charcoal Iron Co., Wells, Michigan.—New charcoal furnace, hot blast, blown in during the summer. Capacity, 80 tons per day. Size, 60 by 10 feet. Described in THE IRON TRADE REVIEW, Oct. 3, 1912, page 619.

Foundries

Malleable Iron Range Co., Beaver Dam, Wisconsin.—New malleable foundry completed early in the year. Capacity, 7,200 tons per annum. Described in THE FOUNDRY, February, 1912, page 61.

Sivyer Steel Castings Co., Milwaukee, Wisconsin.—This company made extensive additions to its crucible steel foundry and installed a converter. Described in THE IRON TRADE REVIEW, Oct. 26, 1912, page 769.

Hubbard Steel Foundry Co., East Chicago, Indiana.—This concern made extensive additions to its plant during 1912, including the construction of a roll foundry. Mentioned in THE IRON TRADE REVIEW, Oct. 10, 1912, page 669.

Chicago Steel Foundry Co., Chicago, Illinois.—New crucible and converter foundry built in the fall of 1912. Size of building, 201 by 101 feet. Capacity of plant, 1,800 tons per year. Described in THE IRON TRADE REVIEW, Sept. 19, 1912, page 529.

Emerson Brantingham Co., Rockford, Illinois.—New gray iron foundry. Capacity, 60 tons per day. Completed in fall of 1912.

J. I. Case Co., Racine, Wisconsin.—New gray iron foundry. Capacity 100 tons per day. Under construction. Will probably be completed in spring of 1913.

Manufacturing Plants

Gisholt Machine Co., Madison, Wisconsin.—New plant for the manufacture of turret lathes, boring mills, etc., completed in the spring. Described in THE IRON TRADE REVIEW, May 30, 1912, page 1166.

Fulton Iron Works, St. Louis, Missouri.—New plant for the manufacture of Corliss engines, air compressors, sugar mill machinery, etc. Completed in summer. It includes a machine shop, foundry, pattern shop, forge shop and store house. Described in THE IRON TRADE REVIEW, Sept. 26, 1912, page 579.

A. O. Smith Co., Milwaukee, Wisconsin.—Extensive additions to the drop forge plant of this company were completed in 1912. The plant now has a capacity of from 100,000 to 160,000 forgings per month. Described in THE IRON TRADE REVIEW, Nov. 14, 1912, page 915.

Bertsch & Co., Cambridge City, Indiana.—New plant for the manufacture of sheet metal working machinery. Built in 1912.

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Missouri.—Considerable progress was made by this company in the construction of a new plant, including foundry, machine shop, pattern shop, etc., for the manufacture of gas engines.

Gary Screw & Bolt Co., Chicago.—This company, a subsidiary of the Pittsburgh Screw & Bolt Co., built a large plant at Gary, Ind. during the year for the manufacture of bolts, machine screws, rivets, etc.

Steel Works

Minnesota Steel Co., Duluth Minnesota.—Construction of new plant at Duluth, which will have capacity of 1,000 tons daily, was continued during the year. This plant will probably be completed in 1913. Descriptive articles published in THE IRON TRADE REVIEW, Feb. 8, 1912, page 349 and June 20, 1912, page 1315.

Laclede Steel Co., St. Louis, Missouri.—Rerolling mill commenced operations at Madison, Illinois in April. Capacity, 48,000 tons per year. Mill is of the continuous type, including 16-inch slitting rolls, 16-inch roughing rolls and 10 and 12-inch finishing mills. Described in THE IRON TRADE REVIEW, April 4, 1912, page 743.

Commonwealth Steel Co., St. Louis, Missouri.—Extensive improvements were made at the Granite City plant of this company, including new machine shop, store house, laboratory and club. Described in THE IRON TRADE REVIEW, March 21, 1912, page 463.

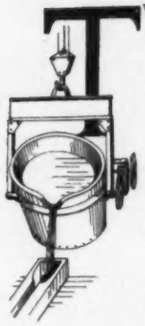
Iron and Steel Direct from Ore

A process, somewhat similar to the Talbot process, for reducing iron ore in a tilting open-hearth furnace, has been proposed by the electrical inventor, Dr. Elihu Thompson. By means of a basic-lined converter, a bath of iron is melted and a blast of ordinary enriched air is introduced to oxidize thoroughly the iron to the magnetic oxide state. By using air enriched in oxygen, a higher temperature is reached. The nitrogen is carried away for other uses by conveyors and its heat can be utilized to preheat the raw materials used in the next stage of the process. After this mixture, the ore and carbon, with suitable slagging materials, are introduced into the liquid bath, the carbon being in sufficient amount to take care of the combined oxygen in the air and in the liquid bath. When desired, it also may be charged in excess to increase the heat by the oxidation of the carbon. It is claimed that this stage of the process produces metallic iron and carbon monoxide in a nearly pure state, suitable for utilization in gas engines for heating, etc. Part of the charge is then poured off and is finished by the proper addition of such ingredients as soft iron for steel. The remainder of the charge is oxidized as stated and the operations are commenced again.

The fall of soot in London has been carefully measured by specially devised soot gages, the work being in charge of the officers of the Smoke Abatement Society, and some extraordinary results were obtained. It was found that the total yearly deposit from the atmosphere was 650 tons per square mile or a total of 76,050 tons per annum for the entire administrative county of London, 117 square miles. This amount includes 8,000 tons of sulphates, 6,000 tons of ammonia and 3,000 tons of chlorides, the balance being carbon and tarry products. The deposit per square mile at Surrey, on the border of the metropilitan area, was only 195 tons per year, or less than one-third of that of London proper.

Making Steel in a Stock, Oil-Fired Converter

Description of the First American Installation Which Has a Melting and Refining Capacity of 1,000 Pounds Per Heat



TWO years ago, a new type of oil-fired, side-blow converter was introduced in England by G. J. Stock, in which the iron for conversion into steel for castings is melted in the same vessel in which the steel is blown, thereby eliminating the cupola, with its contaminating influences, from this steel-making process. During the last two years, 13 installations have been made in England, two in Scotland and single units are in operation in Belgium, New Zealand and Japan. Recently, the first American plant began the manufacture of steel by this process at the foundry of W. P. Taylor & Co., Buffalo, and the Dominion Steel Castings Co., Hamilton, Ont., shortly will place in operation a converter having a capacity of two tons. In addition, the Otis Steel Co., Cleveland, and the Otis Elevator Co., Chicago, each is installing converters of two tons capacity.

Features of the Process

The feature of this process, originally described in THE IRON TRADE REVIEW, Aug. 17, 1911, page 287, consists of the employment of hot blast both for melting and for the conversion of the iron into steel. The blast is heated by the waste products of combustion during the melting operation, in a brick chamber, termed an economizer, which is filled with coils of cast iron pipe. This process permits of the use of pig iron comparatively low in silicon and low in phosphorus, having approximately the following analysis: Silicon, 2 to 2.50 per cent; manganese, 1 per cent; sulphur and phosphorus, 0.035 per cent. As high as 30 per cent of scrap, also can be used in the charges.

The converter installed in the foundry operated by W. P. Taylor & Co. has a capacity of 1,000 pounds. The complete installation is illustrated in Fig. 1, the economizer being located directly at the rear of the converter and is clearly illustrated in Figs. 2, 3, 4 and 5. Owing to its comparatively small capacity, this converter is hand-operated and hand-tilted, the latter movement being effected by a hand wheel and a train of gears, shown at the side of the converter in Figs. 3 and 4. With pig iron selling at $18.50 a ton, steel in the ladle was guaranteed at a cost not to exceed $35 per ton. The total oxidation losses average 16 per cent, including 6 per cent for melting and 10 per cent for blowing, but for a 2-ton plant these losses aggregate only 13 per

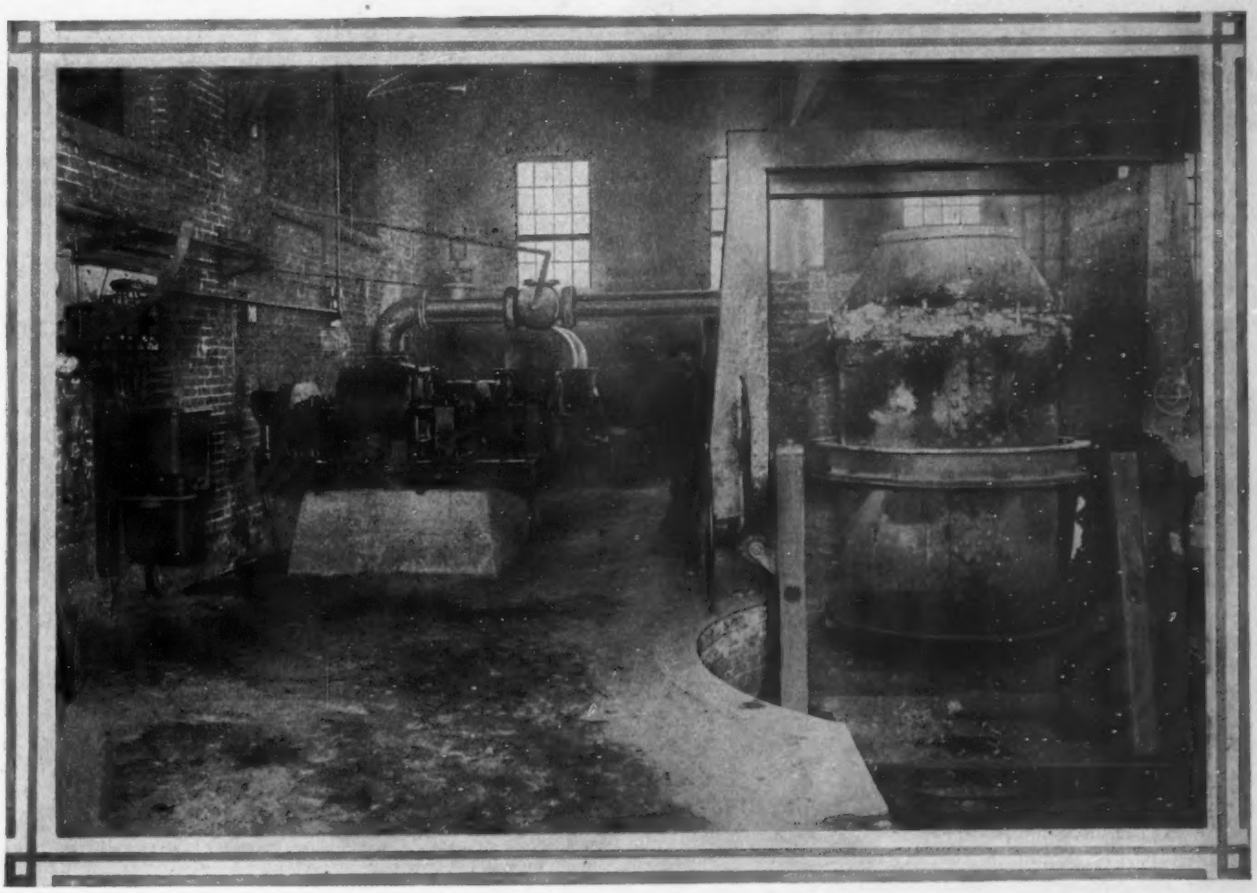


FIG. 1- STOCK OIL-FIRED CONVERTER PLANT OF 1,000 POUNDS CAPACITY, INSTALLED IN THE FOUNDRY OF W. P. TAYLOR & CO.

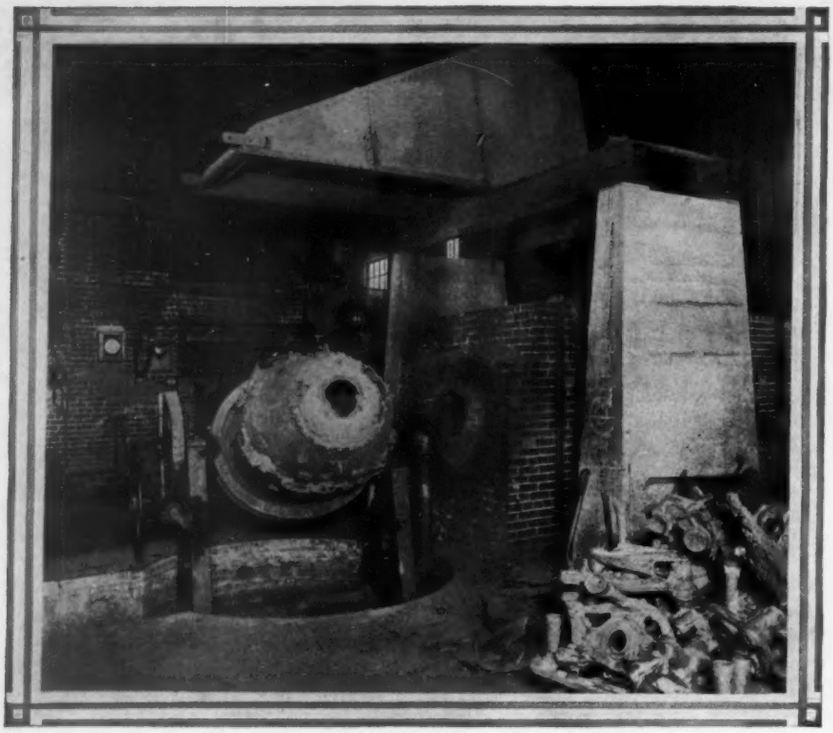


FIG. 2—THE CONVERTER IN CHARGING POSITION

cent. The oil consumption averages 70 gallons per ton for a 1,000-pound plant and the total cost of labor, oxidation, electric power, repairs, oil, etc., approximates $5.50 a ton. On the other hand, a two-ton plant can operate on a basis of 30 gallons of oil per ton of steel manufactured. The net yield of castings at this foundry varies from 55 to 65 per cent, and on small return bends the yield averaged 62 per cent. Owing to the fact that the sulphur content is not increased, which is the case when melting in a cupola, this element can be maintained at the original low basis estimated in the charge and as a result, shrinkage cracks are eliminated and the quality of the steel thereby is greatly improved. The scarcity of fuel oil, which today is a problem of the utmost importance with many steel foundrymen, is not a factor that will militate against the operation of the Stock converter. Any residues from crude petroleum can be used, so long as the oil is not too thick to flow and, in addition, creosotes and products from the distillation of coal tar can be used for melting. The converter can be operated almost continuously for one week without repairs and five heats can be made in 12 hours.

End and side elevations and a plan view of the converter are illustrated in Fig. 6. To facilitate relining, the upper end of the shell is removable. The lining consists of silica bricks and the vessel is mounted on trunnions supported by uprights attached to a steel base plate which forms the top of a turn-table. This arrangement permits the converter to be turned through a complete circle for the various positions of charging, melting and pouring. As previously stated, the 1,000-pound converter is hand-tilted, but this operation is performed electrically on vessels of 2 and 3 tons capacity.

Cold metal, consisting of pig iron and scrap, is charged into the converter by the aid of a peel, when it is rotated into the position illustrated in Fig. 2. In Fig. 3, the converter has been charged and has been rotated again, with its mouth pointing directly into the opening of the economizer, in position for melting. Fig. 4 shows the converter tilted for blowing and in Fig. 5, the converter is in position for teeming the steel into a ladle.

The Oil Burners

The oil burners, which are removable, are located inside of the blast box, the oil being introduced by small steel tubes, three burners being employed for the 1,000-pound converter and six for a converter of 2 tons capacity. The burners for a 2-ton vessel are shown at *A*, Fig. 6. These tubes are centered in the blast pipe and by this arrangement the air and oil are intimately mixed. When the converter is cold, combustion is started by lighted waste, but after the lining has become heated from a previous charge, the oil ignites itself. After the melting operation, the oil burners are withdrawn and the vessel is tilted for blowing the steel, as illustrated in Fig. 4. The time required for melting is approximately 1 hour

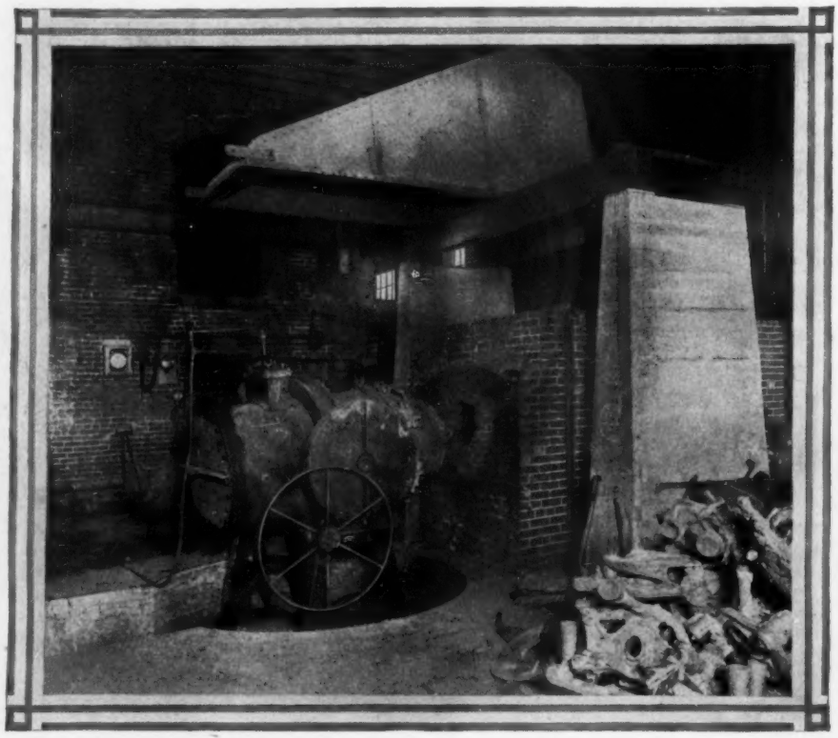


FIG. 3—THE CONVERTER IN MELTING POSITION DIRECTING ITS BLAST INTO THE ECONOMIZER

and 40 minutes, while the steel blowing operation consumes approximately 20 minutes. The pressure of the blast during the melting operation is approximately 12 ounces, but this is increased to from 3 to 3½ pounds during the blowing operation.

The Economizer

The economizer is an important feature of this process and serves to recover the waste heat arising from the combustion of the oil during melting. The brick chamber of the economizer is filled with coils of ribbed, U-section, cast iron pipes, through which the blast passes and the heat from the vessel passes around these pipes before being discharged through the stack. By this arrangement, the cold air delivered by the blower is raised to a temperature of 800 degrees Fahr. before delivery to the converter. The combination of oil and hot blast produces a temperature of approximately 1,600 degrees Cent., thereby greatly expediting the melting of the iron. It has been estimated that there is a loss of temperature in the economizer of approximately 90 degrees Fahr. during the steel-blowing operation. However, the maximum temperature is rapidly attained immediately after the vessel again has been charged and is returned to its melting position.

The blast is furnished by a Roots blower, illustrated in Fig. 1, driven by an alternating current, variable speed motor. This arrangement permits of the control of the blast either at low or high pressures, as desired, without undue expenditure for power. The entire installation can be made in a comparatively limited area and it is equally desirable for plants of any kind requiring a limited tonnage of steel castings, particularly as the process eliminates the installation of the cupola and its accessories. The cupolas in the plant of W. P. Taylor & Co. are so located that a converter could not have been installed to handle the iron conveniently and expeditiously, and by the elimination of this step in the process, it was possible to locate this steel-making plant at one end of the foundry and within a comparatively limited area.

FIG. 5—THE CONVERTER IN POSITION FOR TEEMING THE STEEL INTO A LADLE

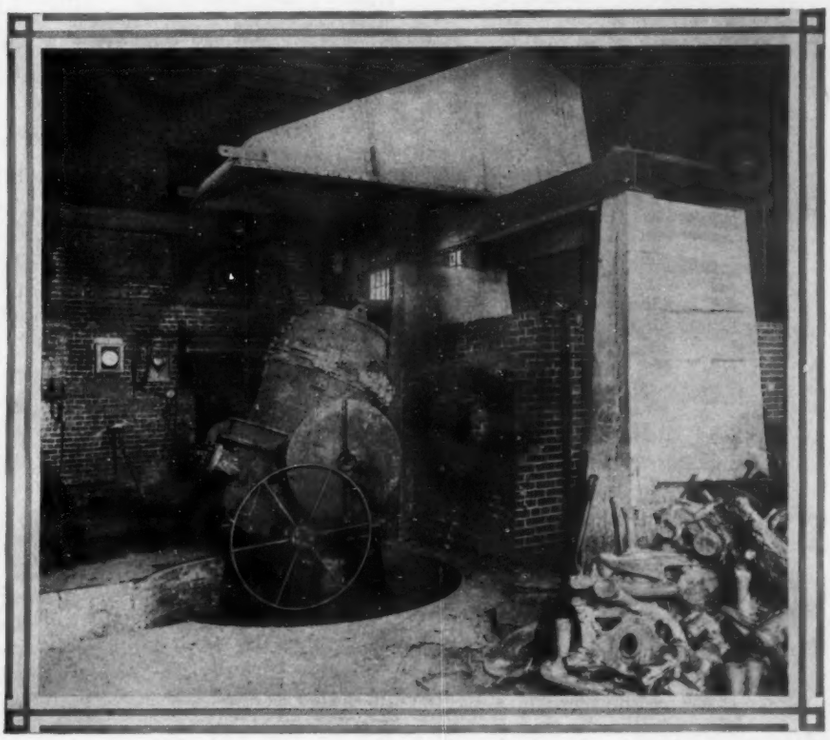


FIG. 4—THE CONVERTER IN BLOWING POSITION, THE OIL BURNERS HAVING BEEN WITHDRAWN FROM THE BLAST BOX

Fluidity of the Steel

The steel can be blown as hot as desired and the metal, which, therefore, is very fluid, is adaptable to the manufacture of small and intricate castings of exceedingly thin section. The metal can be run successfully into castings only 1/16 inch thick. Additions of ferro-silicon and ferro-manganese are made when the vessel is turned down immediately after the blow. The castings that are being made by W. P. Taylor & Co. are unusually free from defects, such as pinholes, blow-holes, etc. In addition, risers, sinkheads, etc., can be reduced in size as compared with those necessary in other steel-making processes. The oxidation losses are reduced approximately one-half by preheating the blast. In the Taylor plant the steel is cast into green sand molds

almost exclusively and silica facing is employed which contains over 99 per cent of silica, the sand being mined in Canada. The surface of the castings is unusually smooth and owing to the purity of the facing sand employed, little difficulty is experienced in cleaning.

Converter and Electric Furnace

An order is being executed for the installation of one of these converters for operation with an electric steel refining furnace. The electric refining period requires approximately two hours and as the steel-making process in this converter approximates this period, hot metal can be furnished to the electric furnace immediately after the previously refined charge has been tapped. To eliminate delays during relining, a spare vessel usually is provided.

Analyses of various grades of steel produced by the Stock converter follow:

Cast steel wheel centers: Carbon, 0.17 per cent; manganese, 0.40 per cent; silicon, 0.17 per cent; phosphorus, 0.05 per cent, and sulphur, 0.025 per cent.

Steel for high carbon wire: Carbon, 0.70 per cent; manganese, 0.40 per cent; silicon, 0.01 per cent; phosphorus, 0.017 per cent, and sulphur, 0.015 per cent.

Low carbon steel for seamless drawn tubes: Carbon, 0.08 per cent; manganese, 0.18 per cent; silicon, 0.011 per cent; phosphorus, 0.011 per cent, and sulphur, 0.01 per cent.

Carbon tool steel: Carbon, 0.83 per cent; manganese, 0.072 per cent; silicon, phosphorus and sulphur, 0.011 per cent.

High speed tool steel: Carbon, 0.627 per cent; manganese, 0.198 per cent; silicon, 0.059 per cent; phosphorus, 0.002 per cent; sulphur, 0.007 per cent.

The foregoing analyses apply to steel made in English plants. For casting purposes, the metal is similar to dead-soft steel and possesses practically the same physical properties. G. J. Stock, inventor of this process, has established an office at 606 Ellicott square, Buffalo.

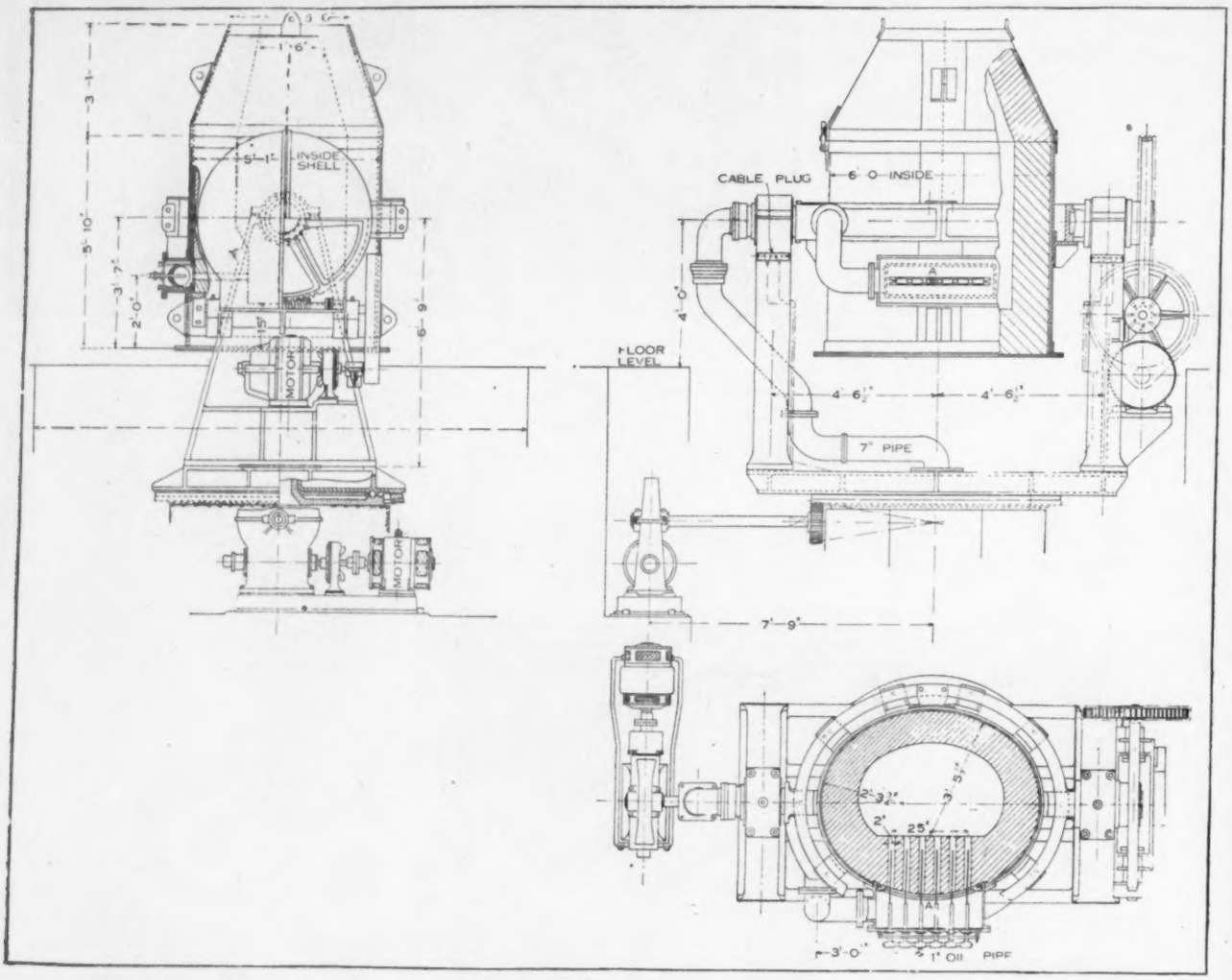


FIG. 6—END AND SIDE ELEVATIONS AND PLAN VIEW OF A TWO-TON, OIL-FIRED, STOCK CONVERTER

Iron and Steel Analyses

An unusual form of trade publication has been issued recently by the American Rolling Mill Co., Middletown, O. Although designated as a bulletin by its publisher, in reality it is a cloth-bound book, illustrated, and contains 62, 6 x 9-inch pages. Under the general title of "Methods for the Analysis of Iron and Steel, Used in the Laboratories of the American Rolling Mill Co., Middletown, O.", a great quantity of valuable material is conveniently arranged. Under separate heads and in easily available form, concise directions are given for the determination of such elements as silicon, sulphur, phosphorus, carbon, manganese, chromium, vanadium, etc. The book would doubtless prove a useful addition to many laboratories.

REVIEW OF LAKE SUPERIOR IRON RANGE DEVELOPMENTS

Record-Breaking Iron Ore Shipments in 1912

UNPRECEDENTED shipments, handled with uncommon ease in the face of a serious labor shortage and occasional traffic difficulties were among the predominant characteristics of the past season on the Minnesota iron ranges. The complete figures show that the lake fleet moved 47,435,777 tons of iron ore during the season from all ranges, to which should be added approximately 1,064,223 tons all-rail shipments, making the total for the year about 48,500,000 tons. This figure has never before been equaled in the history of the iron trade; the nearest approach to it in previous years occurred in 1910, when 43,442,397 tons were moved. The season just closed, therefore, eclipses all previous records by more than 11½ per cent.

Of this aggregate, the Minnesota iron ranges, with which we are directly concerned in this review, furnished 34,107,260 tons equivalent to 70.30 per cent of the entire movement. The importance of the Minnesota ranges in the iron ore production of the country is growing more pronounced from year to year.

How the Record Was Attained

The record achieved in 1910 was brought about only by a great straining of effort in all departments of the ore business, including both the mining companies and the transportation agencies. The results of the season just closed, are, therefore, all the more remarkable since they were accomplished without apparent exertion, and it would have been possible to move 10,000,000 tons more had such a quantity been desired at lower lake ports. This indicates a tremendous increase in the capacity and effectiveness of the mining organizations and transportation avenues during the past two years. There is no doubt now, as a result of this increase in efficiency, that the Steel Corporation will have little trouble in taking out the full minimum requirements of the Hill lease before its expiration.

Table I.

LARGEST SHIPPERS IN THE MESABI RANGE IN 1912.

	Tons.
EVELETH DISTRICT	
Fayal	46,822
Genoa	1,315,867
Gilbert	135,624
Adams	993,600
Spruce	739,915
HIBBING DISTRICT	
Hull-Rust	2,225,000
*Mississippi	270,000
*Mace	130,000
*Harold	187,000
*Dale	1,100,000
*Uno	1,800,000
Susquehanna	500,000
Laura	270,412
Scranton	225,000
Mahoning	1,500,000
CHISHOLM DISTRICT	
*Leonard (Pit)	1,597,128
*Leonard (Underground)	612,917
Chisholm	692,512
Myers	101,558
Clark	498,183
Grace	60,640
VIRGINIA DISTRICT	
Sauntry-Alpena	763,231
Norman	612,973
Fay	262,070
WESTERN MESABI DISTRICT	
*Hill	1,000,000
Canisteo	1,800,000
*Holman	900,000
Hawkins	500,000

The names of mines printed in Roman are owned by the Oliver Iron Mining Co., while those in italics are indipendent mines. The mines held by the Steel Corporation under the Hill lease are indicated by asterisks.

On the Vermillion range the principal shipments by mines are as follows:

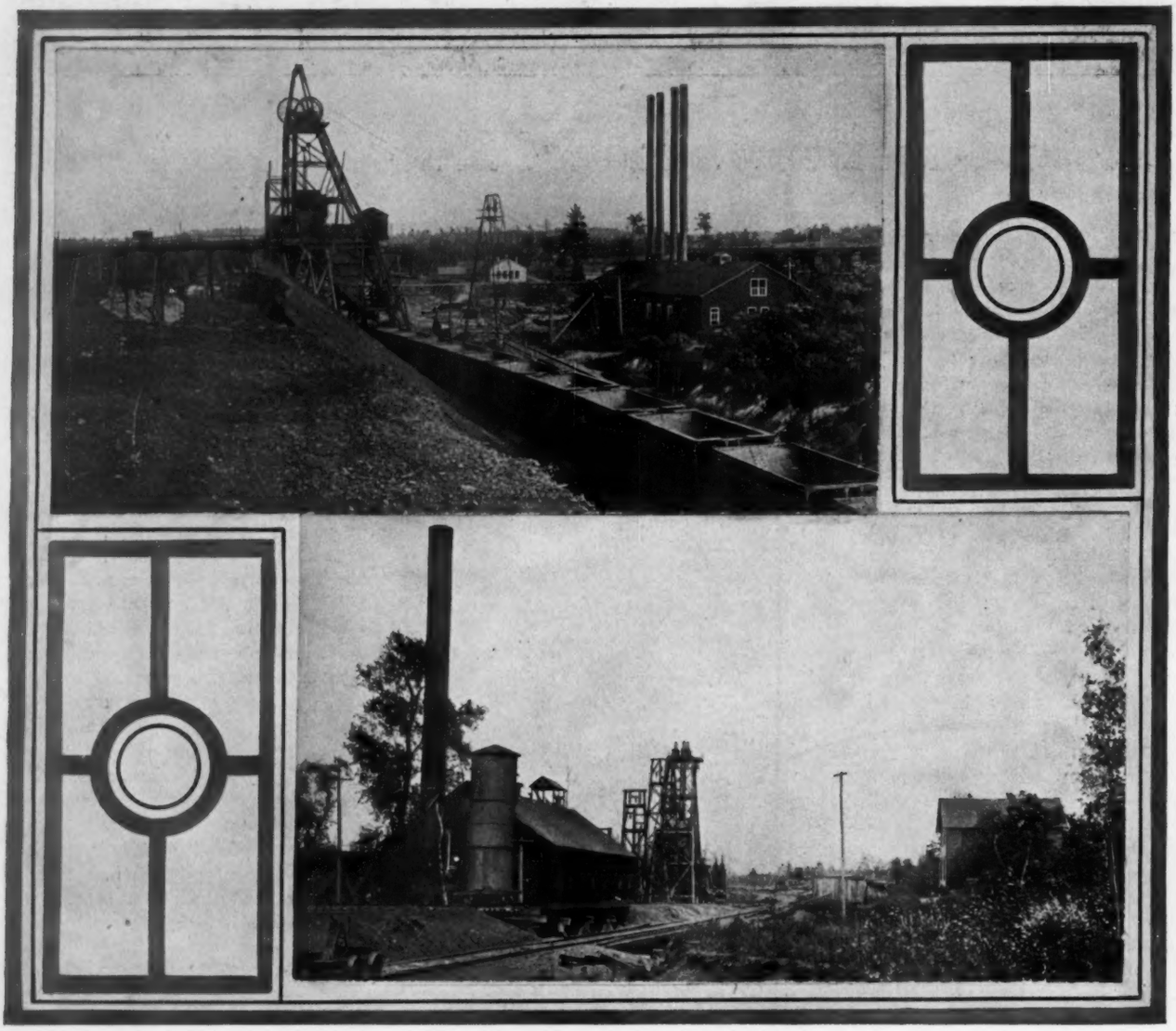
	Tons.
Sibley	309,183
Savoy	90,587
Pioneer	647,336
Zenith	477,317
Soudan	88,714
Section 30	100,000
Chandler	50,000

By virtue of tremendous shipments and a general revival of activity in the iron trade, ore prices for the ensuing year will be appreciably higher than those prevailing in 1912; it is also probable that the lake freight rate will be increased. A considerable amount of the ore sent down in the past season was taken from stock piles accumulated in previous years. These now have been quite generally cleaned up, and if shipments are to continue on the same scale next year, a sharp increase in mining activities will be necessary. Consequently, the development of new properties and the extension of old mines has received a considerable stimulus. Also the railroads have found it necessary to provide improved facilities and to acquire additional equipment, while the dock companies have in many instances learned that changes and improvements will be necessary.

Ore Buying Movement

The close of 1912 found the steel companies with more orders on their books than ever before in their history, and therefore they became anxious to provide for their next season's ore supply at an early date; hence the ore buying movement for the season of 1913 commenced on Nov. 19, 1912, with one exception the earliest date for the past 24 years. The selling season opened with a rush and within two days after Nov. 19, fully 5,000,000 tons had been booked. It had been expected 1911 prices would prevail, but on account

of reduction in freight rates on the Minnesota ore-carrying railroads, 1911 prices were shaded by 10 cents, making the schedule: Mesabi Bessemer, $4.15 a ton delivered at Lake Erie ports; Mesabi non-Bessemer, $3.40; old range Bessemer, $4.40, and old range non-Bessemer, $3.60. This is an advance of 65 cents on Bessemer ores compared with 1912, and an advance of 55 and 60 cents, respectively, on Mesabi and old range non-Bessemer. Although the ore mining companies have been benefited by the reduction in freight rates and ore unloading charges, their taxes have been heavily increased, supplies cost more and it is not improbable that there will be some wage advances.



KENNEDY MINE, LEADING SHIPPER ON THE NEW CUYUNA RANGE

INLAND STEEL CO.'S THOMPSON MINE ON THE CUYUNA RANGE

The 1912 schedule practically wiped out the differential against Mesabi ores. This year, however, there is a differential of 25 cents between old range and Mesabi Bessemer and 20 cents between old range and Mesabi non-Bessemer. This may cause some controversy, and doubt has been expressed as to whether it will be maintained. In considering the new prices, the extent to which Lake Superior ores have decreased in iron content and increased in phosphorus during the past 10 years should be considered. Between 1902 and 1911, the average percentage of iron in Mesabi range ores decreased from 55.0663 to 51.1842 per cent; in the same period, the amount of phosphorus increased from an average of 0.03948 to 0.04646 per cent.

Reduction in Freight Rates

The season of 1912 on the Minnesota ranges was benefited by reduced freight rates on the ore-carrying railroads. These reductions were announced immediately after the close of the season last year. In 1912 a flat rate of 60 cents a ton prevailed from all Minnesota range points to the docks at Duluth, Two Harbors and Superior. Early in the season some doubt was expressed if the Great Northern would meet the new rates, but competitive conditions forced this system into line. The new rates from the older Minnesota ranges also brought about a lower freight charge from the new Cuyuna district, which is served by the Soo line. The rate from Cuyuna range points to Superior in 1911 was 65 cents and this was cut to 60 cents in 1912.

The vessel rate during the past season was exceptionally low, amounting to 40 cents a ton, net, from the head of the lakes. That this rate was abnormally low was proved by

developments later in the season when it was impossible to get wild tonnage except by paying a premium of from 10 to 15 cents, and in one case at least, 60 cents a ton was offered for a cargo from Duluth to Buffalo. The lake rate for the ensuing season has not yet been determined, but there is little question that it will be higher.

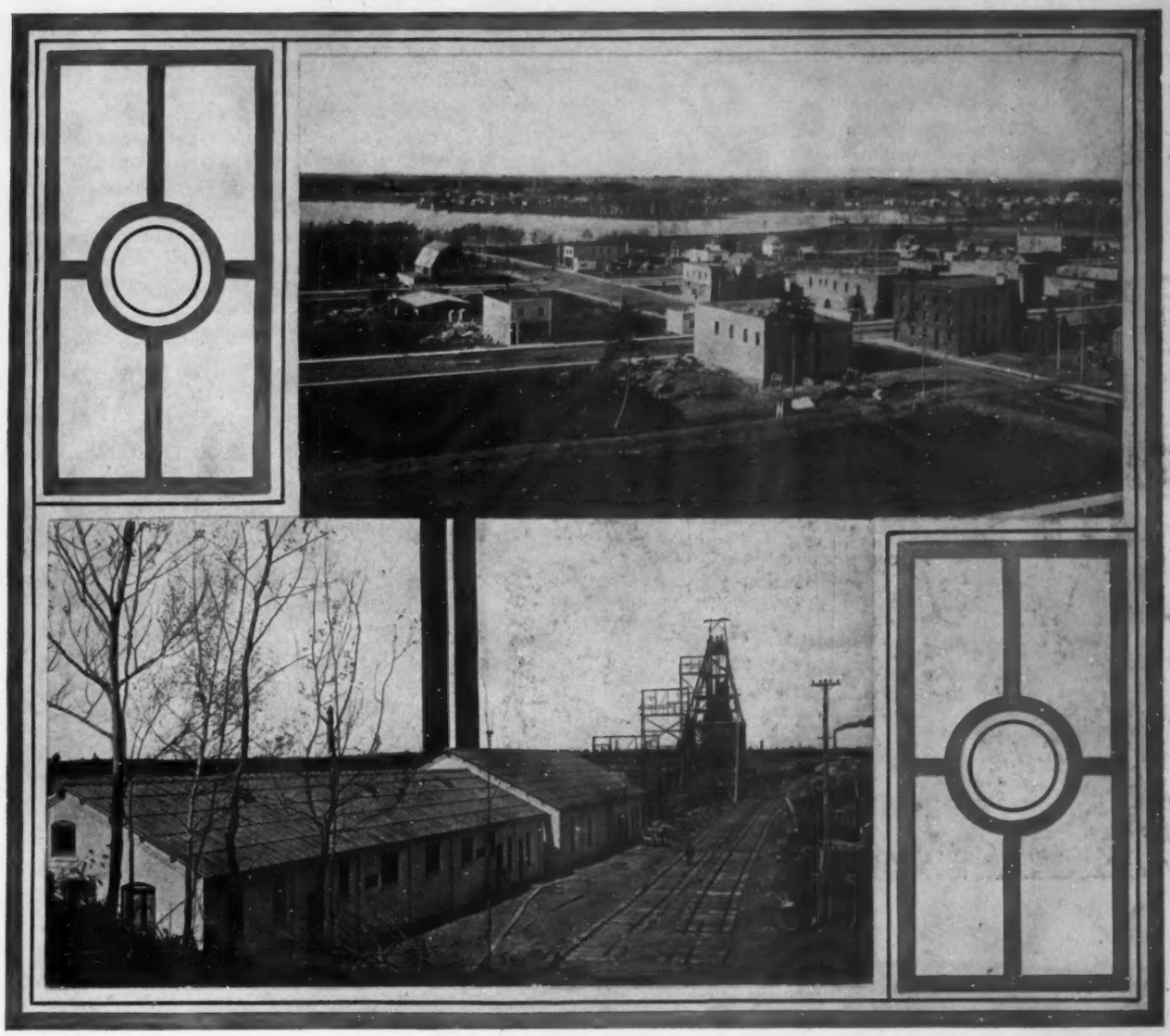
The tremendous shipments from the Minnesota ranges during 1912 afford an interesting subject for analysis and comparisons.

The shipments by ports, from month to month during the season, are given in Table II, which indicates that the port of Duluth shipped 21.6 per cent of all the ore sent down the lakes during 1912, while Superior handled 29.4 per cent and Two Harbors, 19.3 per cent, the aggregate for the Minnesota ranges being 70.3 per cent of the total movement. The heavy shipments from Superior were specially noteworthy and are due to the activity of the Oliver Iron Mining Co. in working the mines held under the Hill lease. By the terms of this lease, the entire output from these mines is handled by the Great Northern railroad, and this system last year shipped 13,935,602 tons of ore over its docks at Superior.

The mines on the Mesabi range whose shipments are entitled to special mention are given in Table I.

On the Cuyuna range from which the total shipments were 305,112 tons, the Kennedy mine forwarded 215,112 tons, and Armour No. 1 and Armour No. 2, approximately 45,000 tons each. These three mines are owned by the Rogers, Brown Ore Co.

The year opened with an unusual amount of ore held in stock piles at the mines. The Minnesota tax commission estimated the total quantity of ore in stock May 1 at 8,170,537 tons. This included over 800,000 tons on the Vermillion range and large quantities in the vicinity of Virginia and Chisholm on the Mesabi range. At the latter point, the Oliver Iron Mining Co. alone had seven stock piles, including probably 2,000,000 tons of ore altogether. A single pile at the Monroe mine contained 600,000 tons. The heavy demand during the recent shipping season made it possible to



CROSBY, MINN., THE THREE-YEAR OLD METROPOLIS OF THE CUYUNA RANGE

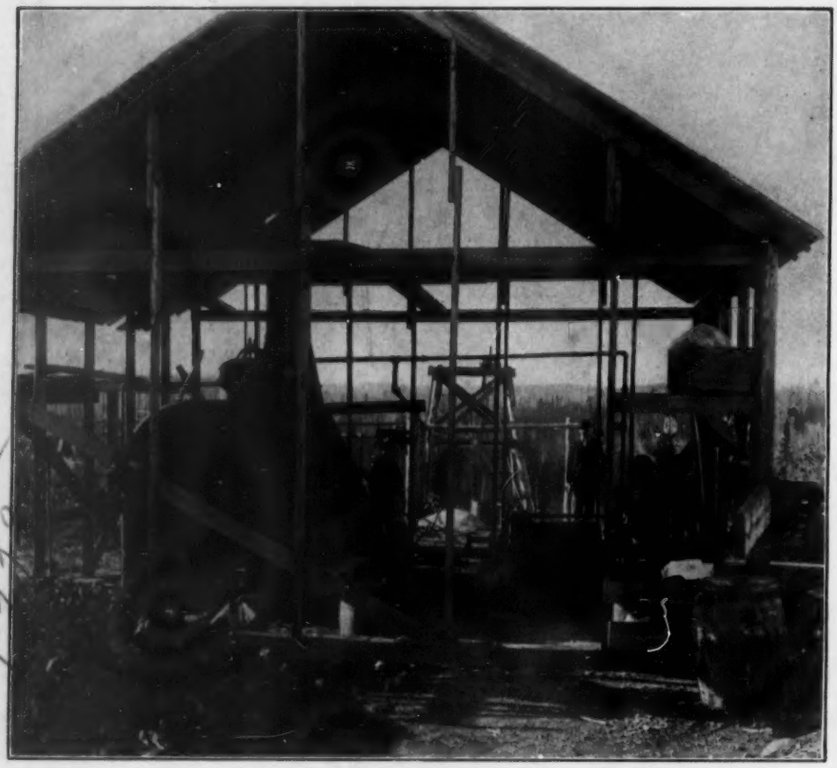
ARMOUR MINE, NO. 2, SHIPPED ITS FIRST ORE IN 1912

The shipments by ranges both for 1911 and 1912 were as follows:

	1912 Tons.	1911 Tons.
Mesabi	32,039,011	22,093,532
Vermillion	1,763,137	1,088,930
Cuyuna	305,112	147,431
Total	34,107,260	23,329,893

The increase in 1912 amounted to 10,777,367 tons, or over 46 per cent.

dispose of the majority of this ore, so that now conditions are reversed from those existing at the beginning of the year, the amount of ore held in stock at the mines being unusually low. On the Vermillion range there is less than 120,000 tons in stock. In the Eveleth district there were 60,000 tons left over from 1911 and about 457,000 tons in stock at the opening of the season. This has all been shipped. At Chisholm where the Steel Corporation held an unusual amount of ore in stock, there is now comparatively little left, six of the seven stock piles on hand at the beginning of the year having disappeared, leaving only 800,000 tons stored at the Monroe mine. It was partly on account of these heavy shipments from stock that the mining companies were able to handle such a phenomenal tonnage in 1912 without excessive effort. An increase in mining activities was not, by any means, as imperative as it would have been, had there been less ore above ground when shipping commenced in April.



POWER PLANT AND HOIST AT THE ALMAR MINE

This is a typical installation and indicates the nature of the equipment required to develop a new property

The Hibbing District

The year's shipments did not seem to reduce the available supply of ore in the Minnesota region to any appreciable extent, new deposits and new mines being opened up constantly. At the present time there is an unusual amount of ore uncovered and ready for shipment in the Hibbing district, amounting approximately to 50,000,000 tons, enough to take care of another year like 1912 with over two million tons to spare.

The extent of the total ore reserves in Minnesota may be appreciated by referring to the figures used by the Minnesota tax commission. This body estimated that the amount of developed and measured merchantable ore remaining in the ground at the close of 1912 was as follows:

	Tons.
St. Louis county	1,233,014,609
Itasca county	167,822,791
Lake county	503,343
Total tonnage	1,401,340,743

This is divided between the two iron ranges as follows:

	Tons.
Vermillion range	10,957,708
Mesabi range	1,390,383,035
Total tonnage	1,401,340,743

The total equalized assessment against this tonnage remaining in the ground is $254,553,179. The total tonnage for 1911 was 1,367,474,853. The total assessment in 1911 was $232,368,469. The tonnage for 1912 thus represents an increase of 33,865,890 tons and the assessment for 1912, an increase of $22,184,710. The increase is due partly to the increased tonnage shown above, but more largely to increases in the assessed valuation of all mineral property made by the tax commission. The assessment of mineral properties on the Cuyuna range shows a large increase over the previous assessment and the iron ore bodies of that range will soon be so far developed that the tonnage may be accurately measured and the grade determined. Table III contains a summary of the tax commission's mineral assessment of iron ore contained in St. Louis, Itasca and Lake counties.

The assessment of personal property, including stockpiles, prospects and mineral lands is not included. The mineral lands containing the above tonnages were assessed in 1906, the year prior to the organization of the tax commission, at $64,486,409. After the adjustments for shipments, stock piles and new tonnages were made for 1912, the tax commission made a general increase of 5 per cent in all assessed values.

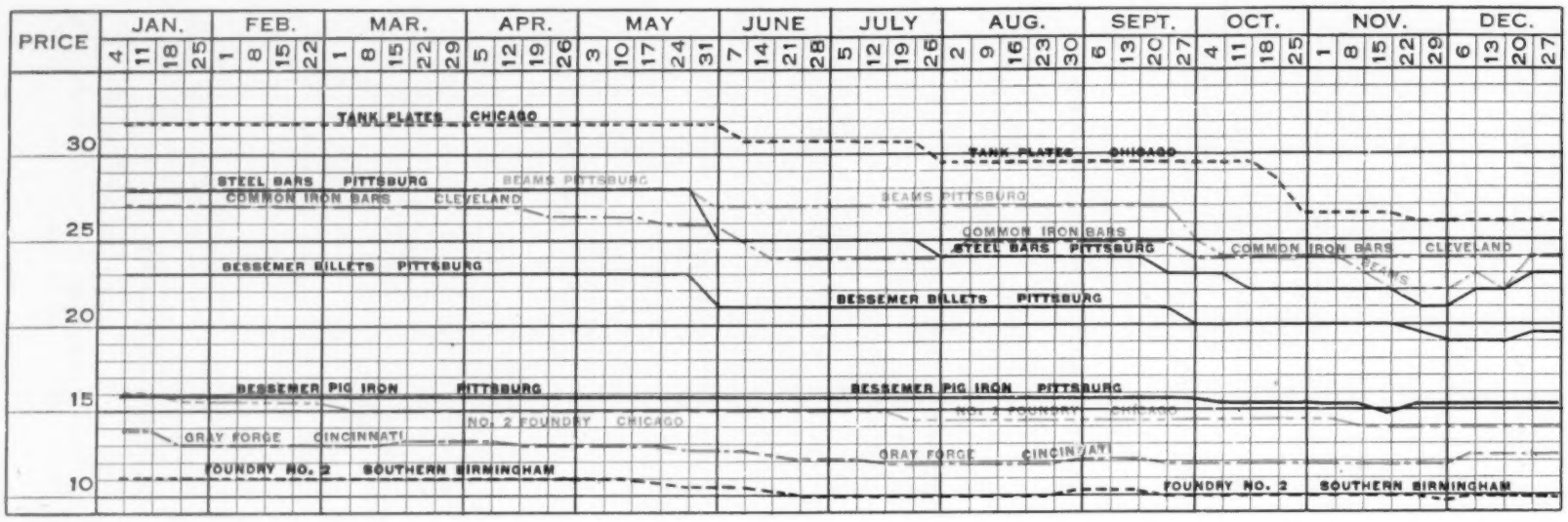
Development of New Properties

In the development of new properties, the activities of the Great Northern interests in the Mesabi range and the growth of the Cuyuna range were of paramount interest during the recent season. It is evident that the Great Northern Ore Co. intends to operate a mining organization of its own and to sell its ore in the open market. During 1912 the Great Northern opened three new mines on the Mesabi range, the largest of these being what is now called the St. Louis mine, near Chisholm. This was formerly known as the J. B. Adams Exploration, and was one of the mines which was included in the Hill lease and turned back to the Great Northern by the Corporation. The Winston-Dear Co. is conducting the stripping operations on this property, which it is expected, will develop into one of the largest mines on the Mesabi range. The stripping will require at least a year-and-a-half, since about 6,000,000 cubic yards must be removed and the season of 1914 will be at hand before this property enters the shipping list. The mine is located southeast of Longyear lake in the southwest quarter of Section 27, Township 58 north, Range 20 west. The Great Northern Ore Co. also has let a contract to Butler Bros. for stripping a new mine west of Hibbing on the southwest quarter of Section 2. This is a comparatively small proposition. In addition, the same contractors are opening another Great

CHARTS SHOWING FLUCTUATIONS IN IRON

Chart Showing Fluctuations in Iron and Steel Prices in 1911 By Weeks

(FINISHED PRODUCTS IN NET TONS. PIG IRON AND BILLETS IN GROSS TONS.)



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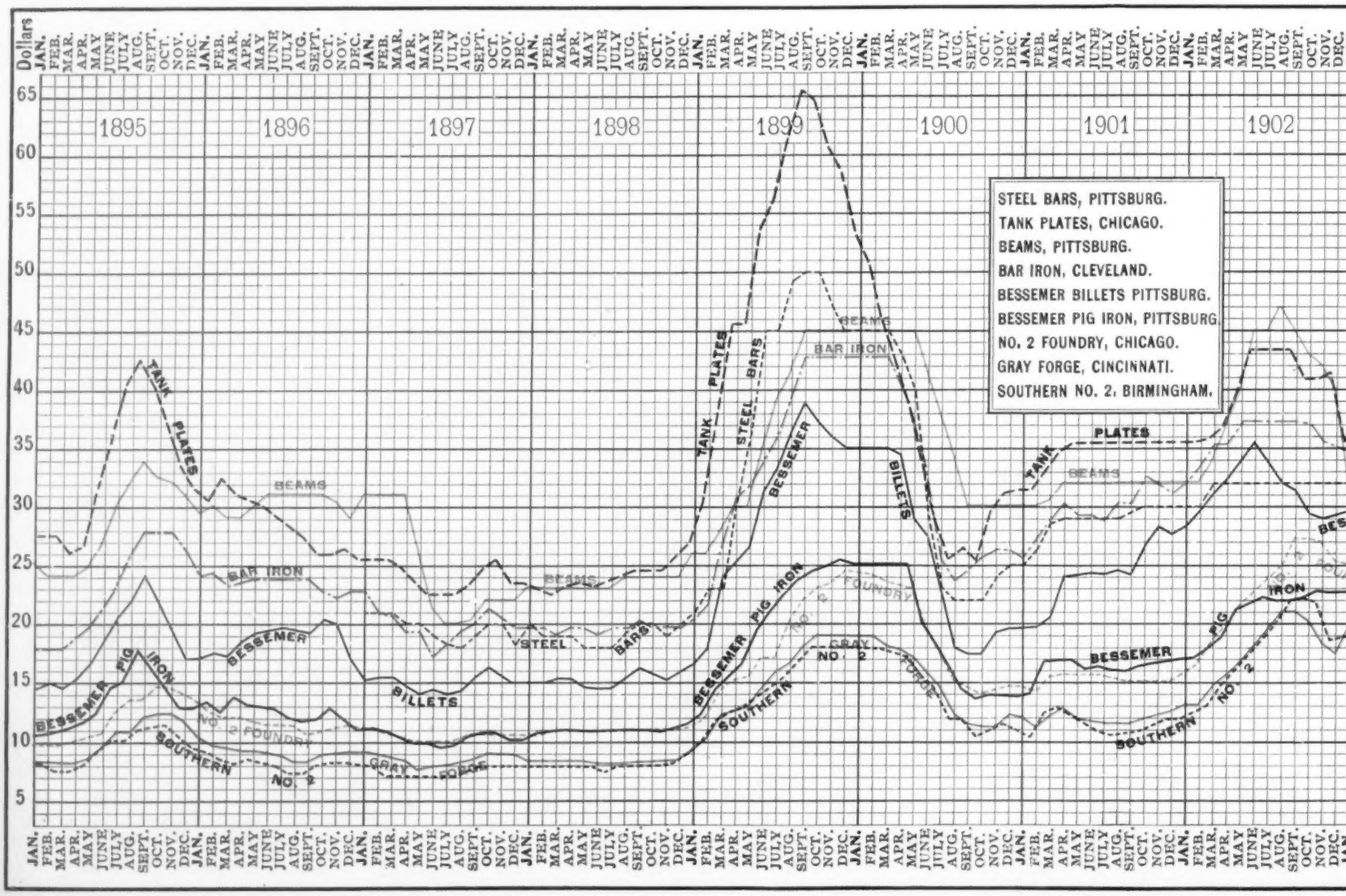
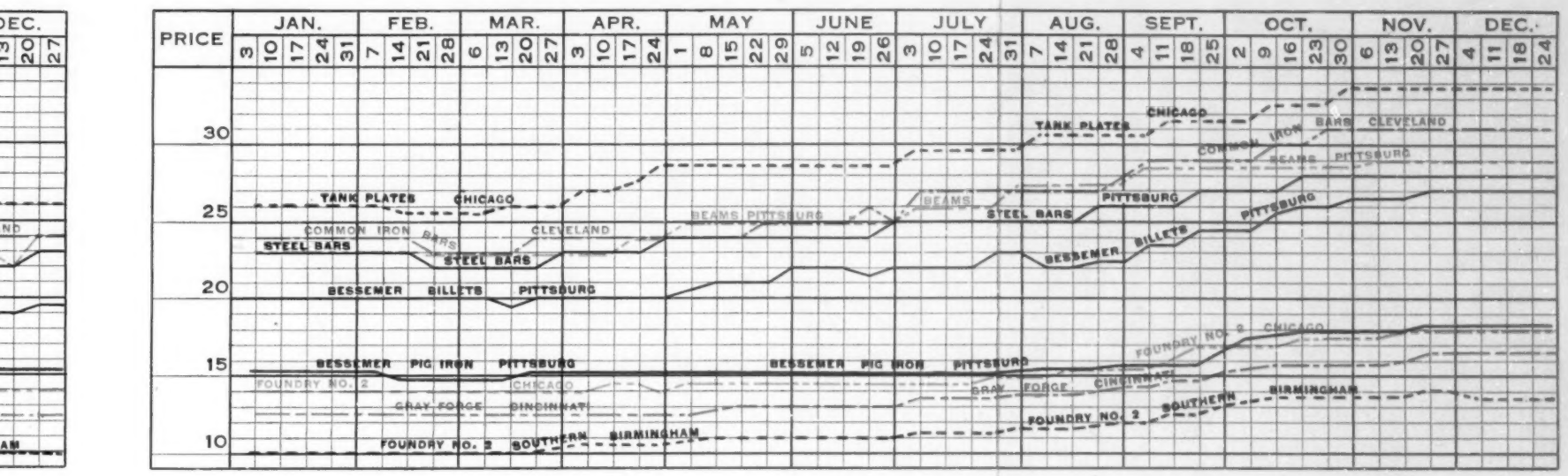


NTRADE REVIEW

IRON AND STEEL PRICES FOR EIGHTEEN YEARS

Chart Showing Fluctuations in Iron and Steel Prices in 1912 By Weeks

(FINISHED PRODUCTS IN NET TONS, PIG IRON AND BILLETS IN GROSS TONS.)



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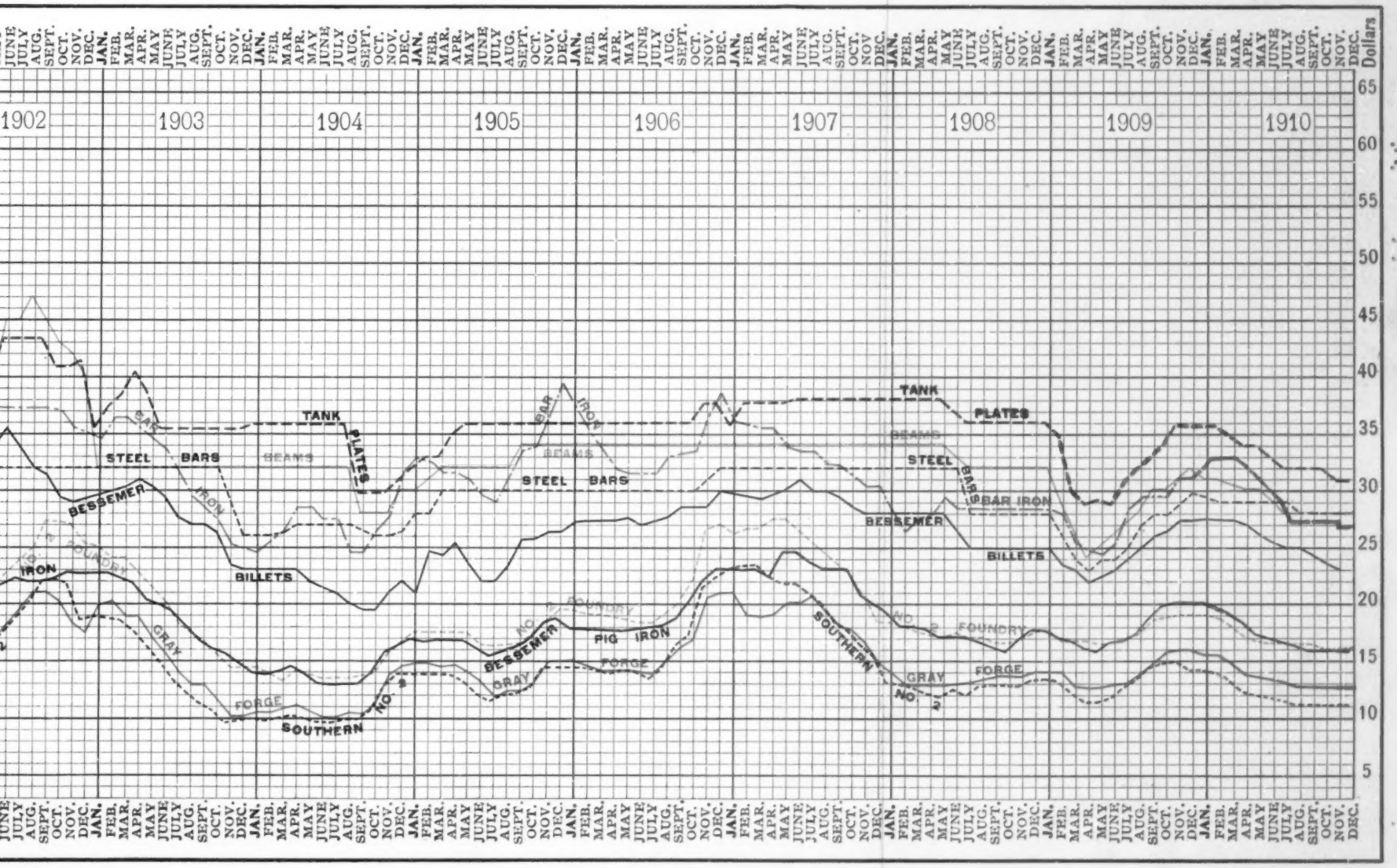

(TABLES OF PRICES ON WHICH THESE CHARTS ARE BASED ARE PUBLISHED IN THE IRON TRADE REVIEW OF JAN. 2, 1913.)

Northern mine east of Chisholm adjoining the Whiteside property.

Coincident with the activities of the Great Northern Ore Co., the Steel Corporation is taking steps to provide itself with mines to take the place of those which will be relinquished at the expiration of the Hill lease. To this end, the Oliver Iron Mining Co. has opened two new mines on the eastern Mesabi range near Biwabik. These are known as the Graham and the Vivian; the former will be a combination open pit and underground property and the latter, entirely underground. They will probably ship ore in 1913. Also, in the past year the Oliver Iron Mining Co. completed its work on the new Leonidas underground mine at Eveleth. A large sum of money has been spent in developing this property, which it is expected will ship next year. The shaft consists of steel sets and concrete slabs and is 400 feet deep. Considerable trouble with water was encountered in sinking the shaft and 1,400 gallons per minute are now being pumped.

Other Development Work

The Longyear & Bennett interests have let a stripping contract to Butler Bros. for the development of the Bennett mine located in the northwest quarter of Section 24, near Chisholm. In the same vicinity the Jordan mine, which shipped 20,314 tons in 1910, but was idle in 1911, has been reopened by local men.

On the western end of the Mesabi range, near Marble, it is understood that the Oliver Iron Mining Co. will develop the Ark Terrace, a property formally owned by Hetty Green. The Great Northern, it is believed, will prepare to cut through to Section 16, a short distance from the Hill mine. Pickands, Mather & Co. have already done considerable development work on Section 9 in the same region, and it is believed will start active mining operations next season.

In the Hibbing district, the Tod-Stambaugh Co. has opened the Morton mine. This property comprises 80 acres, and the ore deposit is figured at not less than 5,000,000 tons. The fee is held by the state of Minnesota.

On the Vermillion range, the North American mine, near Tower, was opened and two new shafts on another property in the same general vicinity, known as the Almar, have been started. This mine is controlled by the Culbertson-Bunker interests of Duluth, who are also developing some property on the Cuyuna range.

The past year witnessed an unusual amount of development work on the Cuyuna range. A complete description of this range was published in THE IRON TRADE REVIEW Jan. 4, 1912. At that time there were five shafts on the range; at present there are eleven. An entire new series of deposits have been opened south of the earlier discoveries, and are known locally as the South range. Extensive drilling explorations in this ore body have indicated that it contains at least 110,000,000 tons of ore with an average analysis slightly below 50 per cent iron. Included in this estimate are 50,000,000 tons having an average analysis of 54.6 per cent. The details of this new deposit were fully described in an article in THE IRON TRADE REVIEW, Nov. 12, 1912, page 923. The present indications are that the Cuyuna range, instead of extending westward across the Mississippi river, bends to the south and follows along the east bank of the river for some distance south of Brainerd.

In the southwest quarter of Section 2, Township 46 north, Range 29 west, north of the town of Crosby, the Cuyuna-Mille Lacs Iron Co., of Duluth, is developing a new property to which considerable interest attaches because there are indications of extensive deposits of high manganese ore. An 8 x 14-foot timber shaft has been sunk 200 feet and a drift started at the 200-foot depth.

At the Adams mine in the northwest quarter of Section 30, Township 46 north, Range 28 west, The Foundation Co. of New York, is sinking a 10-foot, 10-inch by 14-foot, 10-inch concrete shaft, which is now 5 feet from the ledge, having penetrated 122 feet of surface material. Six miles south of Crosby, Pickands, Mather & Co. have sunk a shaft in the southwest quarter of Section 8, Township 45 north, Range 29 west. Two miles north of the town of Cuyuna, the Iron Mountain Mining Co. is sinking a timber shaft, which is down 100 feet.

EXPLORATION SHAFT AT THE ALMAR MINE

This mine is near Tower, Vermillion range, and was opened in 1912

This shaft will be enlarged to three compartments to the 130-foot level. This mine is also understood to have some high manganese ore. Considerable interest attaches to the activity of the Williams & Brown interests, who expect to strip an open pit near Crosby by hydraulic means.

In addition to the new projects, briefly mentioned, there has been considerable progress made in the development and extension of existing properties on the various Minnesota iron ranges during recent months. In the Oliver Iron Mining Co.'s Adams

pit near Eveleth, from two to three shovels will be used all winter in stripping operations. The work at this point is specially difficult, because most of it is in ground which has been previously caved by underground mining operations. The Fayal pit, also operated by the Oliver Iron Mining Co. in the Eveleth district, has been idle since 1910.

In the Virginia district, the Oliver Iron Mining Co. operated the Norman property, although the fee owners have sued for the cancellation of the lease. In the same district, Corrigan, McKinney & Co. will conduct extensive stripping operations on the Commodore mine this winter, and M. A. Hanna & Co. will strip the Silver property.

Table II.

IRON ORE SHIPMENTS BY PORTS DURING 1912

	Duluth, tons.	Superior, tons.	Two Harbors, tons.
May	1,276,027	1,931,307	1,128,983
June	1,551,214	2,348,608	1,445,669
July	1,540,324	2,324,324	1,616,258
August	1,690,650	2,397,535	1,578,221
September	1,652,735	2,031,086	1,508,493
October	1,686,324	2,002,767	1,393,765
November	1,080,066	1,140,767	662,858
December	18,237	64,320	36,722
Total	10,495,577	14,240,714	9,370,969

Hibbing District Development Work

In the Hibbing district, the season was very active, although the large Sellers and Burt pits were idle on account of litigation between certain property owners in Hibbing and the Oliver Iron Mining Co. The Rogers, Brown interests finished their stripping operations on the Susquehanna property, which is now being equipped with a drainage system. Corrigan, McKinney & Co. have succeeded in making some progress with the St. Paul and Stephenson mines west of Hibbing.

In the Nashwauk territory, the new washing plant of the International Harvester Co., operated in connection with the Hawkins mine, was active, and the other independent mines in this region were also busy. The Cleveland-Cliffs Iron Co. is planning on the construction of a washer at Nashwauk to take care of the sandy ores in the Crosby mine.

On the Vermillion range, active development work was prosecuted at the Lucky Boy, Section 25 and White Lake mines, although none of these have shipped ore. The Oliver Iron Mining Co. continued its regular development of the Sibley Soudan, Zenith and Pioneer properties.

The work of developing existing properties was much more active on the Cuyuna range than in the other Minnesota districts. As a result of these operations, Rogers, Brown & Co. now have three thoroughly developed mines, the Kennedy, Armour No. 1 and Armour No. 2. Also, the Inland Steel Co. has practically completed the development of the Thompson mine at Crosby. The shaft on this property is now complete, the machinery is installed, two main levels have been opened and the mine is ready to produce ore.

The work which has been reviewed briefly in the foregoing paragraphs was executed in the face of a rather stringent labor shortage. In the slack times during 1911, a great many men left the ranges, and it was more than usually difficult to induce them to come back last year, on account of the great industrial activities prevailing in other sections of the country. The war in the Balkans also had its effect on the labor situation; a large number of Greek, Servian and and Montenegrian miners left the ranges early in the fall to fight in their native lands.

Car shortages also contributed to the difficulties of the operators during the past season. Early in the year particularly, it was next to impossible to get satisfactory car service from the Great Northern, but conditions improved as the season advanced. On account of the constantly growing number of mines, the number of cars required to handle a given tonnage is increasing.

Improved Railroad Facilities

The unprecedented shipments handled by the Great Northern railroad, amounting to nearly 14,000,000 tons, convinced the Hill interests that extensive improvements are necessary on the lines serving the Minnesota ore territory. Therefore, 21 work trains will be maintained by the Great Northern during the greater part of the winter in the vicinity of Wawina, on the Swan river line, where something over 20 miles of double track will be put in. The D. M. & N. is actively prosecuting the construction of the Spirit Lake Transfer railroad around Duluth, which will connect the plant of the Minnesota Steel Co. with all of the railroads entering Duluth, and with the ore docks of Duluth and Superior.

The Northern Pacific, through a subsidiary company known as the Cuyuna Northern railroad, has built a line, 5¼ miles long, from Deerwood north, tapping the Cuyuna range. In connection with this work, a small steel and concrete ore-shipping pier will be erected in Superior. It will have a capacity of about 1,000,000 tons a year, and will be similar to the new Great Northern dock in design. It will be 1,300 feet long, 70 feet wide and 80 feet high, having a pocket capacity of 60,000 tons.

Among the miscellaneous developments which have improved conditions on the Minnesota iron ranges, should be mentioned the construction of the Mesaba Electric railway from Hibbing to Gilbert. This line will connect all of the towns in the central portion of the Mesabi range, including Hibbing, Chisholm, Buhl, Virginia, Eveleth and Gilbert, and will greatly improve the transportation facilities in this district. The line commenced operating the latter part of December.

Table III.

MINERAL ASSESSMENT OF IRON ORE IN ST. LOUIS, ITASCA AND LAKE COUNTIES

Year.	Tonnage remaining in the ground May 1, each year.	Assessed value.	Shipments, tons.
1907	1,192,509,757	$186,720,326	29,180,975
1908	1,193,728,959	174,273,632	18,098,894
1909	1,310,190,194	199,008,838	29,284,496
1910	1,347,596,291	220,423,038	30,317,583
1911	1,367,474,853	232,368,469	23,329,893
1912	1,401,340,743	254,553,179	34,107,260

Every Branch of the British Trade Booms

Tremendous Activity Interrupted for a Time by the Coal Miners' Strike—Revival of Demand for Iron—Insurance Act Raises Costs

By J Horton

THE prosperous conditions of 1911 have been repeated during the year just ended, but with a marked difference. The year 1912 was a year of progress not only in the volume of output, but in values and wages, so that every department of the industry has fully shared in the benefit. It would have been a record year in every respect, but for the unfortunate occurrence, in March, of the great coal strike, which inflicted injury upon the iron and steel industries, the effect of which, even at the close of a boom year, is still being felt.

The close of the year finds the blast furnaces, in all districts, selling the whole of their output, and iron and steel works not only producing the last ounce of material they are able to make, but with good reserves of orders to carry them forward for some months into the next year. Although shipbuilding has been making records, there is still abundance of work to be done, while naval shipbuilders outside the government yards have work enough to keep them fully engaged for the next two to three years, with the certainty that quite a number of other ocean mammoths must shortly be the subject of contracts. The year differs considerably from its predecessor in that trade activities have brought with them a comparatively steady and thoroughly healthy rise in values. The general conditions could hardly be healthier, and while values are comparatively high there are no signs of inflation, a fact sufficiently obvious from the pressure for deliveries.

High Pig Iron Prices

It is a great many years since pig iron realized anything like its present high values. Selling prices in Cleveland show a comparatively steady rise. At the first week in January, the selling price of No. 3 Cleveland was 50s 9d with the amount in store 540,000 tons. A month later, the price had receded one shilling in spite of a substantial reduction in stocks. It was evident at this time that the expected strike was seriously depressing business. The usual spring purchases of material were practically wholly suspended. The beginning of March brought the strike, with its complete paralysis of the iron and steel trades. The effect in Sheffield alone was to throw out immediately 10,000 men, and stop every works producing iron and steel. After a duration of six weeks, the coal war came to an end in the middle of April, but, long before that time, every blast furnace had been damped down or blown out. While fuel lasted, the pig iron stores in Cleveland continued to be drawn upon for the mills, and stocks were reduced to 420,000, while the price of pig iron had been lifted something like 4s 6d per ton. Blast furnace output was, of course, crippled for several months, and the effect of the strike had been seen in every iron and steel balance sheet since published. As the effect of the paralysis was gradually overcome, the healthy state of trade became more and more evident. By the end of June, the great progress brought the speculator into the market, with the result that Cleveland prices were advanced half a crown in a week, and as much as 1s 4d in a day. Stocks had meanwhile reduced to 314,000 tons. The selling price of No. 3 at that time was 56s 3d. It was considered a bold prediction to say that the selling figure would touch 60s—by the end of the year, but the latest quotation at the time of writing, Dec. 1, is 67s 8d with 68s 6d on "three months'" transactions. Stocks have been diminishing at a somewhat lower rate lately, and there is still a quarter of a million tons in store; but the pace of consumption is increasing, and there is more eagerness to buy than for some time past. It is so many years since prices touched anything like this figure that a pessimistic prediction of reaction seemed to be natural, and to be backed by experience. Consequently, pig iron users held back as long as possible and they are now tumbling over each other to get supplies. It seems certain that much higher figures will be realized before the tide turns. There are no stocks outside Cleveland, and most furnaces are booked three months ahead. A large pig iron producer stated a day or two ago that there are not two days' stocks of pig iron in the country.

If anything, the hematite makers have done still better, advances having been of a very substantial character. The year began with northeast coast mixed numbers at 66s—for January delivery, a price on which makers were very much inclined to congratulate themselves. Steel has had a boom throughout the year, and hematite, therefore, has had no setback whatever since the strike. The selling price is now 82s—or a comfortable rise of 16s—, and fairly bright prospects of still better things. In this department, there are no stocks to encourage speculative disturbances.

Revival of Iron Demand

As to finished iron, there have been some fluctuations in certain classes of iron, but bars, and especially the old-fashioned Staffordshire bars, have had a downright good time. There has never in the whole history of the trade been such a meeting of congratulation and elation as the last meeting of the Staffordshire Iron and Steel Institute. The revival of demand for Staffordshire iron was a feature of 1911, the outstanding element of which was the substitution by the railways of wrought iron for steel in railway wagon underframes. That movement has gone forward with strength and decision, and there is no branch of the iron and steel trade more buoyantly optimistic than the Staffordshire bar trade. Preparations are being made for extending and modernizing several Staffordshire works, and, though prices are stationary for the moment, it seems likely that the progress maintained through most of the year will shortly be resumed.

The official returns under the Midland Iron and Steel Wages Board are the best evidence of the upward movement. The return for the closing two months of 1911 gave an average for the 17 selected firms of £6 13s 3.46d, covering bars, angles and tees, plates and shapes, hoops, strip and miscellaneous. This was a rise of 2s 11d on the previous two months. For Janu-

ary and February, the average gave £6 16s 2.74d. This left wages unchanged, but the next return for March and April, showing an average of £7 0s 5.28d gave the men 2½ per cent advance, and brought puddling wages up to 9s 3d. Selling values continued to rise, and for May and June the selling average was £7 4s 9.81d, with another rise of 2½ per cent. For July and August, the selling average was £7 10s 3.83d, which carried with it still another 2½ per cent in wages. The last return of the year was issued at the beginning of December for the months of September and October. It gave a selling average of £7 17s 7.76d, a rise of 7s 4d on the two months and giving an advance of 6d per ton in puddlers' wages and 2½ per cent to mill and forgemen. With the special bonus given to puddlers, their wages are now 10s 9d per ton. It will be seen from the above figures that the advance in the selling price during the ten months was about 24s. The actual rise on bars alone during that period was 24s 9d. It is remarkable that during the same period plates and sheets advanced only 16s 1d, angles and tees increased 26s, while hoop, strip, and miscellaneous went forward 24s 4d. These figures are very significant not only as showing the lead taken by bars, and their near relations, hoops and strip, but the fact also that galvanized sheets have, on the whole, not taken full advantage of the trade boom, for reasons which may be referred to subsequently.

Puddlers' Wages

In regard to wages it should be added that the Midland Wages Board as the result of negotiations in July added 6d per ton bonus to puddlers' wages, making the rate 10s 3d, as compared with 9s at the beginning of the year. The effect of this serious addition to the cost of production must in itself involve heavy advances in the price of bars and kindred descriptions of iron.

In regard to other classes of iron, the small advance in the value of sheets was a curious feature. This is due partly to keen competition among British makers. There is no department of the iron trade in which productive equipment has been more scientifically developed, and mills are turning out more than ever. The mills of the United States also are, it is believed, competing more keenly than heretofore for the trade in galvanized sheets. At the same time, the continuous growth in exports throughout the year suggests that home competition is the principal influence at work. The galvanized sheet makers are still without any sort of combination, and the more far-sighted members of the trade think the outlook ominous, when the inevitable setback in the trade current arrives. The sheet trade has, to some extent, shared the misfortunes of tin plates through the war in the near east. Apparently, in the tin plate trade the keen competition of the new mills has prevented undue buoyancy. The year commenced with quotations of 13s 6d per box for I. C. 20 by 14, and at the close of the year the same plates are selling at 15s 9d. The war in the east has, for the time being, shut off one of the best customers of South Wales, in connection with the Russian oil trade. But the Welsh mills are very well off for work, and are looking forward to a good year, their principal concern being as with many others in the finished trade, the question of supplies of raw steel.

Problems of Production

The close of the year finds the iron trade mainly concerned with the problems of production. Demand is plentiful, and the maker therefore, has no need to tout for orders. But in many cases he cannot make the best of his plant. There are scores of puddling furnaces unemployed for lack of puddlers. It is recognized that the renewal of this class of skilled labor will be a work of years, and, owing to the spread of education, and the resultant dislike of strenuous labor, the best type of workman is apparently rather shy of the puddling furnace. South Staffordshire ironmasters and managers are looking round very keenly for some more successful mechanical puddler than has yet appeared on the scene, and it is believed that there is a golden opportunity for the inventor who can produce puddled iron in blooms approximating to the size of ordinary steel ingots, and of satisfactory quality, almost wholly by mechanical means. This is the subject uppermost before the Staffordshire Iron and Steel Institute at the present time, and an evening is to be devoted, early in the new year, to the consideration of the Roe puddling furnace, which some ironmasters believe to be the most successful type of mechanical puddler yet introduced.

Every branch of the steel trade has had a boom. But price advances have been on a moderate scale. At the commencement of the year, steel ship-plates were £7 5s, and steel joists £6 10s. Successive advances have taken place with the result that ship-plates are now £8 to £8 5s, and steel joists £7 7s 6d, with other prices in proportion. The last advance was declared in the middle of November, and it seems likely that the makers will content themselves with maintaining present figures for some time to come. A year ago, a lively controversy was in progress over the offer of steel manufacturers to allow a rebate of 5s to their customers, on the understanding that they bought only from British makers, instead of from foreigners. The opposition both of merchants and constructional engineers was so determined that failure was pretty confidently predicted by the interested parties. The movement apears to have been completely successful, and nobody now thinks of grumbling at the rebate. The steel trade is more strongly organized than ever, and as hardly any foreign material is coming into this country, the British houses have practical control of the market. It is admitted on all hands that if steel makers cared to do so, they could advance prices much more liberally. Their own account is that the association has been used, not to promote, but to restrict advances, and this view is generally accepted. The explanation is the anxiety of steel makers to retain the market for British steel, one motive for this being the greater recognition of the importance of maintaining large outputs. A certain amount of Belgian, cheap finished steel is coming in, but it is not enough to count at all seriously.

Tremendous Demands

The country has consumed more steel than ever, and it is not impossible that records may yet be made, in spite of the gap caused by the coal strike. Every steel-using industry is making enormous demands for material. It is now recognized that the railways have bought too economically in recent years. To some extent the limitation of orders for rolling stock was due to the numerous railway amalgamations, which enabled carriages and wagons to be more efficiently utilized through the cutting off of unnecessary and unprofitable trains, both in the passenger and goods departments. It seems that this was carried somewhat to an extreme. One of the first effects of the trade revival was a congestion on the railways, which constituted a very serious problem in the

early months of the year. It is somewhat less troublesome now. But every line in the kingdom is wanting rolling stock, and a fair number are also needing rails. The Sheffield and Northern works have splendid order books, securing full employment for some months into the new year. But there has also been a great development of railway enterprise, largely on account of the extension of municipal areas, as in Birmingham for example, which has taken in several neighboring towns, and laid numerous lines of tramways. Those steel houses which specialize on tramway sections have done extremely well, and have comfortable prospects.

Railway Buying

Every one of the Imperial dependencies has bought heavily of railway material, India having been especially a good customer, while the great trade revival in South Africa, which has at last escaped from the depression following the war, has brought numerous home orders. The parcels of iron and steel sent to the colonies have similarly been bigger than ever. There is hardly a railway works but is increasing its productive capacity, and looking forward to a very prosperous year in 1913.

The shipbuilding trade has also made new records, and the rise in freights has done much to encourage the building of cargo steamers. The great ocean lines have built several very expensive passenger steamers, and others are still being ordered.

The few yards devoted to naval shipbuilding, outside the government dockyards, have had a splendid run of activity. Barrow-in-Furness has a fine record, and the Tyne yards are especially busy. Such firms as Cammell Laird, John Brown & Co., and Vickers & Sons, are all heavily booked forward. The outburst of patriotism which has brought Canada and the principal colonies forward with offers of battleships to supplement the Imperial navy has been a great windfall to the British shipyards, while almost every foreign navy, dependent on outside supplies for its battleships, has brought substantial orders to Great Britain.

The building industry has left its own record of steel consumption far in the rear. Every important building is now made with a framework of steel, and this change of fashion will bring a valuable, permanent customer to British steelmakers. Tens of thousands of tons are on order for this purpose alone.

Unfinished steel has been scarce practically all the year. Quite a large number of works are at the present time dependent on practically day-to-day consignments of raw steel, to enable them to continue. The fact that throughout the whole period neither America, Germany nor Belgium has come to the help of the embarrassed consumer with billet supplies, is taken as convincing evidence of the enormous activity in those steel-making countries. British consumers, at any time during the year, would have vociferously welcomed foreign consignments, if they had been obtainable. The close of the year finds clamant demands from South Wales for tin plate bars, from South Staffordshire for wire rods, and from Sheffield for billets for the production of various kinds of finished steel. This strain upon the mills has kept selling prices at a higher level throughout the year. Yet, on the whole, the rate of advance has been moderate. In January, Bessemer sheet bars were selling at £5 5s and at the beginning of December prices ranged from £5 17s 6d to £6 2s 6d for Bessemer quality.

The great activity of engineering, and the large demands for mill furniture and machinery have kept the foundries in a state of constant activity throughout the year.

A peculiar feature has been that in spite of the great activity in structural engineering, all such contracts have been the subject of keen competition, and the engineers themselves complain that their branch of the business is decidedly unremunerative. Apparently, there is great need for mutual understanding amongst structural engineers, to prevent unduly whittling away profits. But of any such understanding there is not the remotest prospect at the present time.

Some Difficulties

It is agreed on all hands, that, while trade has been abundant, it has also been carried on under difficult conditions. The coal strike completely dislocated coke supplies, and these have never been restored in adequate quantity. For weeks after the end of the coal strike, some furnaces were unable to restart for want of fuel. Even within the past few weeks, certain furnaces owned by large companies have had to be put on slack blast, because all their coke supplies were cleaned up. Dear fuel is a factor to be constantly reckoned with, as an element both in cost and selling prices. Coal has advanced several shillings during the year, and now costs at least five shillings more per ton than before the upward movement in prices. This alone has added 10s per ton to ironmasters' charges. Then, the insurance act which came into operation in July added a new responsibility to employers, who have to find three pence per week towards the insurance of every worker in their employ. In the early days of the act, the opposition was tremendous, and its authors were very fortunate that this measure, coming in the time of trade boom, was less of a burden upon industry than it would otherwise have been. It now appears to be working smoothly; but in great steel works and shipyards, particularly, it has enormously increased the cost of production.

Scarcity of Labor

The year closes with scarcity in all ranks of labor employed in iron and steel works. There are now furnaces both in Cleveland and Barrow-in-Furness, which would be restarted, if men could be obtained to work them.

The scarcity of puddlers has already been referred to, and a peculiar feature, apparently agreed to by all authorities, is that the substantial rise in wages given exclusively to puddlers in midsummer, so far from encouraging the men to put in more time and energy, has had the opposite effect. Holidays and rest times are more popular than they were. This is particularly galling to employers, who have not only furnaces idle for lack of men, but are unable to get production on a proper scale, from the furnaces in operation.

The hope expressed a year ago that some substantial result in the want of international action by steelworkers would follow the Brussels conference, initiated by Judge Gary in 1911, has not been realized. The general explanation on this side is that Judge Gary has been too much engrossed with the anti-trust agitation to materialize the purposes with which the International Association was established. However, there is general satisfaction that no urgent necessity for international action has arisen.

Outside the engrossing labors of manufacture, events of paramount importance, calling for special mention, are not numerous. The meeting of the Iron and Steel Institute at Leeds, in the autumn, was of unusual

interest. Owing to the number of very practical subjects considered, the impression upon the steel makers and experts who attended is that the earnest consideration of such practical questions as segregation of steel, and kindred subjects, will bear very substantial fruit in the future. Undoubtedly, the election of Arthur Cooper as president has borne fruit in a quickening of interest, and a concentration of attention on practical subjects. To a lesser degree, the same might be said of the May meeting which displayed great interest in mill driving machinery for steel rolling mills, and in the adoption of special means of dealing with blowholes and cavities in steel. In technical circles, there is a great belief that the trade is about to make important steps forward in the production of improved qualities of iron and steel. It was not found possible to make up for the omission of the Turin visit arranged for in 1911, but an invitation has already been received to make Brussels the meeting place in the autumn of next year, and the idea appears to find general favor.

Handsome Profits

The profits of companies fairly confirm the general impression of business prosperity, though the coal strike left a deep mark on a good many of the balance sheets. For example, Bolckow, Vaughan & Co. lost £108,000 through the strike, but were still able to pay a 5 per cent dividend. Bell Brothers realized £81,000, William Roberts, Tipton, paid 10 per cent, Guest, Keen & Nettleford paid 10 per cent and a bonus of 5 per cent making profits for the year £395,000. Hadfields, Ltd., for the fifth year in succession paid 17½ per cent dividend, besides carrying forward £50,000. Cammell-Laird paid 7½ per cent dividend, the Metropolitan Amalgamated made a profit of £308,000 and paid 10 per cent dividend with a 5 per cent bonus, or as the chairman described it, "a monotonous 15 per cent," and this company has a reserve fund of £550,000. William Jessop & Sons made a profit of £71,000, and paid a dividend of 10 per cent. John Brown & Co. continued the average of 10 per cent, paid over the last 15 years, and has recently issued £150,000 preference shares.

An interesting event in March was the formation of the Scottish Iron & Steel Co., which acquired 13 malleable iron firms having a combined output of 250,000 tons per annum.

Apart from the railway strike, the iron and steel industries have had rather more labor disturbance than usual, but real strikes have been on quite a small scale. A movement which at one time had an ugly look was the claim of the puddlers made last summer for increased bonus and a material reduction of hours. To enforce this, the men gave notice to terminate the wages board, but the notice was withdrawn on the concession of the bonus of 6d per ton, and the declaration "That the hours of work for a puddling furnace be considered 11 hours for six heats, and 9½ hours for Saturdays on the weekly average, but that in the case of gengeneral excess of this time, the operatives may bring forward such case for the consideration of the standing committee." There was a fear, when this bonus was given, that other claims would follow from other classes of ironworkers, but this fear proved to be groundless. An effort was made in October to combine all the labor unions connected with the iron and steel trade; but the effort was defeated by an overwhelming majority.

A matter of considerable interest to America is the great change in the character of the Welsh tin plate trade. It has already been pointed out that price advances have been distinctly moderate, and the explanation of this is that Wales has now practically wholly lost the American rebate trade; that is to say, that portion of the Welsh exports returned to Great Britain in the form of tin cans containing food. Welsh makers are also concerned over the fact that, according to American statistics, the makers in the States shipped 45,000 tons, during the first six months of the present year to British or neutral markets formerly served by South Wales. The Welshmen estimate that the Americans have won from them in recent years tin plate business to the extent of 150,000 tons a year, or over 3,000,000 boxes, equivalent to the output of 100 mills.

Prospects Bright

A word need only be added as to the prospects for the new year. The immense demand both at home and abroad must secure a huge output for several months to come. A large number of bridge contracts are now in hand, one of the largest of which is a bridge over the lower Ganges, comprising 15 spans, each of which will weigh 1,300 tons. Another 10,000 tons of steel will be wanted in connection with the elevated water reservoir at Buenos Ayres. The demand for naval shipbuilding will be enormous. News has just been received of India's decision to contribute three super-dreadnoughts and nine cruisers to the British navy. This offer, though not yet officially corroborated, is expected to materialize. Following upon the gifts of five ships from the Malay States and several others from different parts of the empire, it is evident that the British yards will be overwhelmed with work for some time to come. In spite of high prices, there is every sign that demands upon all branches of the British iron and steel trade must for some time tend to increase.

Baryta in Ore

The presence of baryta in iron ore, and even in small quantities, is decidedly detrimental and yet many analyses, particularly from American chemists, do not contain any consideration of the absence or presence of this material in the iron ore determinations. As a result of this rather loose practice, one proposition which progressed to an interesting stage was entirely abandoned upon the receipt of information from a foreign analyst that the ore contained an appreciable amount of baryta which had been entirely overlooked by a number of chemists on this side.

The conditions of the iron ore trade are such at present that most complete and accurate analyses are called for at an early stage in the negotiation of iron properties; for certain minor impurities, or undesirable ratios of common accessory minerals will radically affect the availability of the ore for the purposes intended, or indeed sometimes for any commercial purposes.

Greatest Western Coal State

Colorado leads all western states in the production of coal, according to the United States geological survey, and in 1911 was second only to California in the production of gold. Colorado is also the leading western state in the manufacture of pig iron and of coke, and is the leading state in the production of tungsten ores and vanadium minerals. The total value of all the mineral products of the state in 1911 was $51,958,239. The following statement shows the values of the principal mineral products in 1911:

Gold	$19,138,800
Coal	14,747,764
Zinc	4,814,562
Silver	3,958,800
Lead	2,755,800

Unprecedented Wave of Prosperity in Russia

Wonderful Revival Follows Period of Deep Distress—Inadequate Ore Supply—Many New Railroad Projects—Making Agricultural Implements

THE state of the Russian iron trade for a long time has been exceedingly satisfactory. There has been a steady growth in the production for a number of years until this year, the returns for which shows that when it closes on Jan. 13 next, it will easily have exceeded any production in any preceding year in the history of the Russian iron industry. This is speaking more particularly of the Donetz basin, which contributes by far the largest quantity of iron to the country's total.

The rolling mills have been kept particularly busy all the year round; more, however, for home uses than for export, although it will be remembered that some years ago Russia was exporting more rails than any other country for a period. Roofing iron is a great feature of the Russian industry, probably because the losses by fire are very serious year by year, whole villages and small towns being wiped out from time to time; and consequently the government, both imperial and local, encouraged as much as possible non-inflammable roofing, a great industry in the Urals.

Poverty Prevailed

In connection with the present flourishing condition of the Russian iron trade, the Urals present a striking picture; because only a year or two ago the iron works in that district were in a state of deepest distress, and the workmen of many of them were actually maintained at the cost of the government through the free distribution of food. But after a general revival the Urals have acquired not their old commanding position in the Russian iron industry, but their old activity, and the iron works are hard put to it there as in South Russia to get sufficient ironstone to supply all they want. It is a case of an unexpected boom coming on the top of a prolonged depression, and finding the supplies of raw material practically altogether wanting. Of course along with the strong persistent demand for half and finished products, prices have risen also. The story of the pig iron famine is well known and need not be recapitulated excepting very briefly. It arose originally through the cholera epidemics in South Russia which caused large numbers of the miners to leave for home. The result was such a shortage of ironstone and pig iron that special measures had to be passed admitting pig iron into the country for the requirements of the metallurgical works, engineers, etc.

A Foreign Creation

It is true that the South Russian iron industry is largely a foreign creation; but it appears to be impossible to transplant a complete foreign organization on to the Russian fields. The idiosyncrasies of the governing bodies and the lack of appreciation on the part of the Russian engineers of the value of organization are plainly apparent. Although they cannot altogether defeat the superior organization imported into the country, they can hamper it, and one of the effects is to be seen in the present situation. It is quite different with the railway system, which is a government one; and the government and the local industrial magnates take council respecting the quantity of goods that will probably be carried over the lines for a considerable period ahead. The estimates are made, and what is quite exceptional in Russian industry, whether it be governmental or private, takes place: i. e., the requisite provision is made in the form of locomotives and wagons for serving the collieries and iron works; and it is rare to hear complaints of wagon shortages, as is the case so often in western Europe, in Germany, France and Great Britain. The other fields where iron is produced are the Baltic provinces, the Moscow district and Poland, and are also quite prosperous; though not to the same degree as South Russia. The areas named, however, manage to supply the local wants to a large extent; but the advantage of production on a large scale rests with the Donetz basin which can make its influence felt as far away as the Urals, the iron producers of which complain that they suffer from the handicap of Donetz competition, because of the cheaper production in the last-named area.

This is an interesting comment on cheap labor because labor is much cheaper in the Urals than it is in South Russia. Nevertheless, the South Russian fields, by reason of their better organized factories, are able to compete with the Urals on fields that would be considered their exclusive reserve. There has been, from time to time of recent years, talk of establishing an iron industry in Siberia, but progress in this direction is little spoken of now.

So long as the government shows a warm side to the innumerable new railway projects that are submitted for its approval, and authorizes the construction thereof in such proportions as have obtained for the last year, the rail rolling mills are assured of full work and are not likely to trouble the world's market. But one result of the demand for government and private railways in the country is of necessity the extension and improvement of existing rail rolling mills whose capacity for production will tell heavily on the outside market, when the present home railway boom is exhausted. But this may be a long time coming; because industrial and mineral Russia is being rapidly discovered, and railways are likely to undergo a long period of development, as new industrial and mining areas acquire favor and require connection with the markets.

The Commercial Treaty

Considerable progress has been made of late years in the production of agricultural implements in Russia and this particular branch has received a strong fillip by reason of the denunciation by America of the commercial treaty with this country, so that the government lends a hand along with the zemstvos (local councils) to national producers of these goods. It creates another demand, and an increasing one, on the country's metallurgical resources. Altogether the Russian iron and steel business is on the top of a great and unprecedented wave of prosperity which may last longer than is usual in other industrial countries, because the import lists show that the home demand is not satisfied even now with the home supply, so that the home market is quite equal to maintaining not only the present metallurgical system, but even a considerable extension thereof.

Pittsburgh Market Review

(*Continued from page 3.*)

additional orders. Much of the tonnage carried over Jan. 1, 1912, proved to be speculative in nature, as rather heavy cancellations were made the latter part of the month.

Prices Higher

At the opening of the year, steel bars were quoted at 1.15c and iron bars at 1.35c. A number of makers advanced steel bars $1 a ton about the third week of January, but less than a week later the market displayed unexpected weakness and steel bars again were quoted at 1.15c. By Feb. 22, several mills willingly were accepting 1.10c for steel bars and 1.30c for iron bars. On March 28, the Carnegie Steel Co. advised the trade that it would refuse to shade 1.15c for steel bars, and bar iron makers, about that date, advanced prices $1 a ton. This action, needless to say, stimulated the trade to a great extent. Several steel bar makers, about April 11, advanced products $1 a ton. On April 18, the Republic Iron & Steel Co. announced that it would not shade the 1.20c quotation, and the leading interest took similar action two days later. The Carnegie Steel Co., on June 26, advanced steel bars $1 a ton, and iron bars, in the meantime, had advanced to 1.40c as a maximum price. Another $1 advance in the price of steel bars was noted Aug. 22, which established products at 1.30c, and this quotation prevailed until the middle of September, when the bulk of the tonnage was being placed at 1.35c. The Republic Iron & Steel Co., a month later, opened books for first quarter delivery at 1.40c for steel bars, and that figure became general a few days later.

Iron bars continued to display strength, and were quoted at a range from 1.40c to 1.45c the latter part of July. Early in September this product was advanced $2 a ton, and two advances of $1 each were experienced in October. In November, iron bars were quoted at a spread from 1.70c to 1.80c, for forward delivery, and the bulk of the tonnage the last month of the year was being booked at the maximum figure. Steel bars advanced $6 a ton during the year and iron bars advanced $8 a ton.

Wire Products

All of the wire mills in this district enjoyed a profitable year. Demand was unusually heavy and specifying was to the full extent of contracts in almost every instance. Wire products were advanced four times since the early part of the year.

From Dec. 11, 1911, until March 11, 1912, wire nails were quoted on the basis of $1.55 a keg, and plain wire was quoted at $1.35. From March 11 until July 22, wire nails were quoted at $1.60 and plain wire at $1.40. On Aug. 26, nails and wire were advanced $1 a ton and another $1 advance was announced Oct. 9 by the Jones & Laughlin Steel Co., establishing nails at $1.75 and wire at $1.55. Other manufacturers of wire products did not advance quotations at that time. Galvanized products were advanced $2 a ton, Oct. 12, by the leading interest.

Heavy Shipments

Shipments to all parts of the country were exceedingly heavy, and unusually large tonnages were shipped to the Canadian northwest. Demand for barb wire did not fall off, mills advise. Consumers in the west and the southwest continue to use considerable barb wire. In the eastern states, barb wire is rapidly giving way to the woven product.

During the last 14 years, wire nails have sold as low as $1.15. This quotation prevailed from Dec. 23 to Dec. 28, 1898. The highest figure at which nails have been quoted during the last 14 years is $3.20 per keg. This quotation prevailed from Dec. 30, 1899, until April 21, 1900.

The wire market in 1912 was much more satisfactory than that of 1911. At the beginning of 1911, wire nails were quoted at $1.70; two advances of $1 each were made and on June 20 a $1.80 base price for nails became effective. Within a couple of months, prices began to soften and by the beginning of December quotations had dropped to $1.50.

At no time during 1912, were nails sold below $1.55. Instead of a gradual rise, followed by a rapid decline, as in 1911, the 1912 market was one of gradually upward tendency, prices at the end of the year being $4 above those in effect at the opening of 1912. Many in the trade have said the market never reflected greater strength than that displayed the last six months.

Manufacturers of iron and steel pipe enjoyed one of the most successful years in the history of the industry. All serviceable pipe mills operated at maximum capacity during almost the entire 12 months, and nearly all makers carried heavy tonnages over Dec. 31. At the beginning of the fourth quarter, few manufacturers could accept additional pipe orders, being unable to promise delivery this year. Although both iron and steel pipe were advanced a couple of times during the year, prices have not been considered high.

Changes in Pipe Lists

By far the most important event in the pipe trade this year was the informal announcement by the National Tube Co., on Nov. 27, that lists and classifications would be changed generally Jan. 1, 1913. Hereafter leading makers of steel pipe will not manufacture what has been known as merchant-weight pipe—pipe under 6 inches in diameter, varying from 5 to 10 per cent off the official list in weight. It is obvious that the manufacture of this pipe made it possible for some mills to reap benefits. All steel pipe will not vary more than 5 per cent from the official list in weight.

In past years steel pipe has been made on the iron pipe weight basis. Hereafter, all weights will be figured on the basis of 1 cubic inch of steel weighing 0.2833 pound; iron pipe weighs 2 per cent less. Thus it is seen that the quality of steel pipe will be greatly improved.

New discounts are based on the classification of Jan. 1, 1913, and show some increases and some decreases in cost. Smaller sizes will continue to sell at practically the same discounts formerly offered on merchant-weight pipe. On sizes from ⅛-inch to and including 15-inch steel pipe, decreases are noted on the following sizes: 3½-inch, 4½-inch, 13-inch, 14-inch and 15-inch. One-eighth-inch, ¼-inch, ¾-inch, 8-inch, 10-inch, 10-inch and 12-inch pipe remain unchanged, and the other 17 sizes are increased. Increases are slight, however, as it must be remembered that the standard of weights has been changed in favor of the buyer. Independent manufacturers of steel pipe promptly adopted the new classifications and discounts of the leading interest.

The only disadvantage seen in the new method of pipe manufacture will be the temptation to make merchant-weight pipe and sell it at prevailing discounts as full-weight material, or "something just as good". It is to be concluded, however, that the intelligent purchaser will insist upon receiving standard weight pipe.

Structural Shapes

What has been said of steel plates applies, in a great measure, to structural shapes. Under another heading are given the most important structural contracts of the year, which in themselves indicate that both fabricat-

ors and erectors enjoyed a successful season. During the first three months of 1912, structural material was quoted at 1.15c, and did not show the weakness displayed by steel plates in February. The latter part of April, manufacturers advanced shapes $1 a ton, and another advance of the same amount was noted early in May, which established the market at 1.25c. During July and August, structural shapes were quoted at 1.30c, and at no time in that period was any weakness displayed. The 1.35c quotation held until the middle of September, when products were advanced $1 a ton. Four weeks later, material was advanced to 1.45c. This quotation was maintained throughout the remainder of the year by the Carnegie Steel Co.; leading independent manufacturers, the last seven weeks of the year, quoted shapes at 1.50c, and some mills refused to shade 1.55c and 1.60c for forward delivery. It was practically impossible, during November and December, to obtain material for anything like prompt shipment. Structural shapes during the year advanced $6 a ton.

Billets and Sheet Bars

Demand for semi-finished steel products the last six months of the year was unusually heavy, and resulted in an acute scarcity of both billets and sheet bars. Consumers were unable to obtain desired tonnages and none of the finishing mills was able to operate at maximum capacity because of the shortage. Although production will be greatly increased in 1913, it is not probable that the situation will be relieved until late in the second quarter, unless unexpected cancellations are made. About Jan. 18, the leading interest dropped out of the market, being unable to produce surplus tonnages, and one by one other mills were forced to withdraw.

The year opened with both Bessemer and open-hearth billets quoted at $20, and both grades of sheet bars at $21, mill. Early in March, mills began to shade prices and billets declined 50 cents, but the market assumed its former position within a week or ten days. The market began to develop strength the latter part of March and by May 16 prices had advanced approximately $1.50 a ton, and at the end of that month billets were selling at $3 above the prevailing quotations at the beginning of the year. Sheet bars, in the meantime, had advanced $2 a ton. In June, a temporary decline was noted, prices on all products falling about 50 cents. By the end of the first half of the year the market had been established on a substantial basis, and no further declines were noted. Rather sharp advances characterized the market in August and September and at the end of October Bessemer billets were selling at $26.50 and open-hearth billets at $27. By the end of the year semi-finished products were quoted as follows: Bessemer billets, $27.50; open-hearth billets, $28.00; Bessemer sheet and tin bars, $28, and open-hearth sheet bars, $28.50. The Jones & Laughlin Steel Co.'s plant at Aliquippa, Pa., began making steel early in January.

Sheets

All previous records for the production of sheets in this country were broken in 1912. Mills operated at almost full capacity during the 12 months, although at times the scarcity of raw material affected the output considerably. The year opened with blue annealed products quoted at 1.40c, for No. 10 gage; No. 28 black at 1.90c and No. 28 galvanized sheets at 2.90c, but by the end of the month prices began to soften, and by the middle of February a number of mills were selling at $1 a ton below the quotations that ruled during the first four or five weeks of the year.

Decreases continue to characterize the market, and by March 7 black sheets had dropped to 1.75c, for base size—$3 a ton below the minimum quotation at the beginning of the year. Galvanized products, in the meantime, had declined $2 a ton, and were selling at 2.80c.

The American Sheet & Tin Plate Co., apparently foreseeing a period of prosperity, announced on about March 21 that it would refuse to sell galvanized products at less than 2.90c for No. 28 gage. This step had a well defined effect upon the general sheet market, for from that time makers began to maintain maximum rather than minimum prices. The bulk of tonnage being sold by the week ending April 4 was on the following basis: No. 10 blue annealed, 1.40c; No. 28 black, 1.80c, and No. 28, galvanized, 2.90c. On April 18, the leading interest advanced blue annealed and black products $1 a ton and galvanized $2 a ton. A month later products were selling at the following prices: No. 10 gage blue annealed, 1.40c; No. 28 gage black, 1.95c, and No. 28 gage galvanized, 3c. About the middle of July, black sheets were advanced $2 a ton and galvanized products $3 a ton, and blue annealed sheets, in the meantime, had advanced to the 1.45c basis. Early in September blue annealed products were advanced $1 a ton to the 1.50c base; black were advanced $2 a ton, to the 2.15c base, and galvanized products were advanced $3, No. 28 gage, being quoted at 3.30c. By Oct. 12 we find the following prices: Blue annealed, 1.65c; black, 2.25c, and galvanized, 3.40c, for base sizes, and these figures represent the prices at which the bulk of the tonnage for shipment the first six months of 1913 was sold. During the last three months of the year, fancy prices were paid for prompt shipment. Summarizing prices throughout the year we find the following spreads:

	Gage No.	Low.	High.	Range, per ton.
Blue annealed....	10	1.35c	1.65c	$6.00
Black	28	1.75c	2.25c	10.00
Galvanized	28	2.80c	3.40c	12.00

It might be explained that some of the largest producers did not sell at the lowest prices given in the above table, although considerable tonnage during February and March was obtained at relatively low prices. Maximum figures do not include prices paid during the third and fourth quarters for prompt delivery.

On April 18, the American Sheet & Tin Plate Co. commenced quoting sheet mill roofing products upon the basis of weight instead of area. Previous to that time, these products were sold by area, the unit of measurement being the square of 100 square feet and the new method makes it practically impossible for the seller to furnish a lighter gage than called for.

Tin Plate

Manufacturers of tin plate did not enjoy the high prices in 1912 that prevailed throughout 1911. For the 12 months ending Dec. 31, 1911, tin plate makers obtained an average of $3.61 for base size tins; in 1912, the average was $3.46. During half of 1911, base size tins sold at $3.70; this figure was not reached in 1912.

In all other respects the year just ended was a much more satisfactory one. Prices gradually advanced throughout the entire year, and the market was on a decidedly sound basis. Mills operated at maximum capacity ever since the early part of January, and the production of all the mills will exceed that of any previous year, figures for the first 10 months indicate.

Government statistics show that for the first time in the history of the trade, exports of tin and terne plate in 1912 will exceed imports of the same products by a broad margin, which is indeed gratifying to those

directly or indirectly interested in the tin plate industry of the United States.

The tin plate market, like that for other products, apparently was in a healthy condition at the beginning of the year. The $3.40 quotations for base size tins was being firmly maintained. Eighty per cent of the serviceable mills were operating at full capacity. A month later, the market began to show signs of a decided slump; independent mills began shading prevailing prices. By Washington's birthday, it was possible to obtain tonnage at $3.35, although the leading interest maintained the $3.40 quotation. On March 7, tonnage was going at $3.30, base, and this quotation was not withdrawn until April 4, when the market began to reflect the first genuine strength of the year. All serviceable mills were again put into operation, and by the end of April the $3.40, base, quotation, was being firmly held.

On May 23, the leading interest advanced prices to $3.50, for base size tins, and this price immediately was adopted by other manufacturers. Early in September, prices were advanced $2 a ton, and since that time tin plate has been quoted at $3.60, base. The bulk of the tonnage for 1913 was booked at that figure. Consumers covered requirements much earlier this year than in former years. Tin plate during the year sold at a spread from $3.30 to $3.60, a difference of $6 a ton.

Old Materials

The market for iron and steel scrap is an interesting one because of the fact that it generally acts as a reliable index to the entire iron and steel situation. Experiences in past years have led the trade to realize that the market for old materials is usually the first to reflect strength and weakness. With the possible exception of a slump that hit the market in November, such was the case in 1912. Prices during the entire 12 months steadily advanced until early in November when, because of the fact that consumers had built up unusually large stocks during a rapidly rising market, the unexpected came, and quotations declined $1 and $1.50 a ton. Heavy melting steel, early in the year, sold at about $12.25. During February, this stock sold at an average of $12.30. Prices continued to advance, and during June heavy melting averaged $13.31. In November, heavy melting steel was sold at $16.50, the highest price obtained in a number of years. Other grades experienced similar advances. About the middle of November, prices began to decline, and heavy melting steel went as low as $15. Taking everything into consideration the year was an exceptionally good one for iron and steel scrap dealers. They were able to buy at comparatively low figures, and sold stocks at fairly high prices.

Labor Conditions

With one or two exceptions the year 1912 was free from any serious labor disturbance. Plants of the Carnegie Steel Co., at Homestead and Braddock, and the Carrie furnaces, were crippled the latter part of November as the result of a strike including about 500 trainmen, who were out about two weeks. Men returned to work at the wage formerly received, after an unsuccessful attempt to obtain an increase.

The demand for iron bars and the consequent gradual advances in price proved beneficial to members of the Amalgamated Association of Iron, Steel and Tin Workers, employed in the union mills in the Youngstown and central western district. At the close of the year, puddlers identified with the Amalgamated association were receiving 15 cents more a ton than members of the Sons of Vulcan. Members of the latter organization receive a straight $6 rate. At the regular bi-monthly settlement, Nov. 12, the Amalgamated association rate was advanced from $6 to $6.15.

The following table indicates the bi-monthly averages since the beginning of 1910:

AMALGAMATED BI-MONTHLY SETTLEMENTS.

	1910.	1911.	1912.
January-February	1.4849	1.3108	1.187
March-April	1.4825	1.2886	1.195
May-June	1.44375	1.2647	1.195
July-August	1.4655	1.246	1.2518
September-October	1.3983	1.242	1.3351
November-December ...	1.359	1.207	.....
Average	1.4423	1.2598	.....

The annual averages from the bi-monthly settlements since 1906 are:

ANNUAL AVERAGES.

1906.....	1.587
1907.....	1.627
1908.....	1.386
1909.....	1.360
1910.....	1.4423
1911.....	1.2598

Note.—Shipments were made during the periods specified, and resulting wages were paid for the following two months.

New Construction

Open-hearth steel plant additions and extensions characterized the new construction work in the immediate Pittsburgh district in 1912. Reports submitted by the leading iron and steel manufacturers indicate that 50 new open-hearth steel furnaces were under construction at the end of the year, although a few of these will not be in operation until the third or fourth quarter of 1913.

The Youngstown Sheet & Tube Co.'s open-hearth plant, consisting of six 100-ton open-hearth steel furnaces, will be in operation about Feb. 1, and the new open-hearth department of the Brier Hill Steel Co., seven 75-ton furnaces, is now well under way. The Pittsburgh Crucible Steel Co. is building eight 75-ton open-hearth steel furnaces at its Midland, Pa., plant, which will give this company the advantages of a modern open-hearth steel department.

The Carnegie Steel Co. is adding 14 75-ton open-hearth furnaces at its Edgar Thomson works and two 60-ton furnaces to its Clairton battery; the Cambria Steel Co., has built three 75-ton open-hearth steel furnaces at the Franklin works; the Jones & Laughlin Steel Co. has completed four 250-ton Talbot open-hearth steel furnaces at the Aliquippa works; the Republic Iron & Steel Co. expects to have two additional 65-ton open-hearth steel furnaces in operation Aug. 1; La Belle Iron Works is constructing a 60-ton open-hearth steel furnace; the American Steel & Wire Co. is completing a 65-ton furnace at the Donora (Pa.) Steel Works, and the American Sheet & Tin Plate Co. is building two 40-ton furnaces in the open-hearth steel department at the Apollo works, Vandegrift, Pa. The Page Woven Wire Fence Co. is now operating both of its open-hearth furnaces. Aside from open-hearth steel furnaces actually under construction several interests are contemplating the building of open-hearth departments. Additional open-hearth steel capacity, which means increased production, will relieve greatly the present scarcity of open-hearth steel products.

Three new blast furnaces, all of most modern type, are under construction. The Pittsburgh Steel Co. is building two 500-ton blast furnaces at Monessen and the Youngstown Sheet & Tube Co. expects to operate its new 500-ton furnace in April.

The Carnegie Steel Co., the Youngstown Sheet & Tube Co., the Brier Hill Steel Co., the Cambria Steel Co., the Jones & Laughlin Steel Co., the Republic Iron & Steel Co. and the Pittsburgh Crucible Steel Co., are making rather extensive extensions to finishing mills—noted in an accompanying table, under the heading of "Steel Works and Finishing Mills".

The Jones & Laughlin Steel Co. is building 240 rectangular coke ovens at Woodlawn, Pa., and the Republic Iron & Steel Co. has completed plans for a 1,000 by-product coke oven plant.

Most important work of construction undertaken in the Pittsburgh district

is included in a separate table in this report.

Blast Furnaces
(Non-Merchant)

Blast Furnace D, the Youngstown Sheet & Tube Co., 500-ton. Will be in operation about April 1.

The Pittsburgh Steel Co., two 500-ton blast furnaces at Monessen. Will be in operation in the late spring.

Nos. 1 and 2 stacks at the Carrie plant, the Carnegie Steel Co., increased in dimensions, making them 400 and 450-ton furnaces.

New stoves added to Hazelton furnace No. 1 of the Republic Iron & Steel Co.

Steel Works and Finishing Mills

Carnegie Steel Co.—Fourteen 75-ton open-hearth steel furnaces under construction at Edgar Thomson Works; two 60-ton open-hearth steel furnaces under construction at Clairton Works; 10-inch merchant bar mill under way at Duquesne Works; a new blooming mill and a 3-high sheet bar and rail mill being built at Edgar Thomson Works and a slack barrel hoop mill being constructed at the McCutcheon plant.

Youngstown Sheet & Tube Co.—Open-hearth steel plant with six 100-ton furnaces, will be in operation about Feb. 1. Extension to soaking pits, doubling capacity, and a 44-inch blooming mill, to be in operation about April 1.

Brier Hill Steel Co.—Open-hearth steel plant with seven 75-ton furnaces. A 40-inch blooming mill; a 600-ton pig iron mixer and a finishing mill. Capacity 1,000 tons of ingots daily. Not yet completed.

Cambria Steel Co.—Three additional 75-ton open-hearth steel furnaces, with cranes, charging machines, additional equipment, etc., at Franklin open-hearth steel works.

Jones & Laughlin Steel Co.—One 20-ton Bessemer converter; four 250-ton Talbot open-hearth steel furnaces; 40-inch blooming mill; 21-inch billet mill and 18-inch bar mill put in operation early part of year at Aliquippa Works.

Republic Iron & Steel Co.—Reconstructing 8-inch, 12-inch, 16-inch and 20-inch bar mills at Brown-Bonnell Works, to be completed about April 1; two 65-ton open-hearth steel furnaces and one pit furnace, to be completed about Aug. 1.

Pittsburgh Crucible Steel Co.—Eight 75-ton open-hearth steel furnaces; a 500-ton pig iron mixer; a 40-inch blooming mill, under construction at Midland Works.

La Belle Iron Works.—One 60-ton open-hearth steel furnace under construction.

American Steel & Wire Co.—One 65-ton open-hearth steel furnace at Donora (Pa.) Steel Works. Will be completed early this year.

American Sheet & Tin Plate Co.—Two 40-ton open-hearth steel furnaces under construction at Apollo Works, Vandergrift, Pa.

Sheet and Tin Plate Mills

The Wheeling Sheet & Tin Plate Co.—Organized early last fall and is building 10-mill plant at Yorkville, O., near Wheeling, W. Va.

The Washington Tin Plate Co.—Remodeled old four-mill plant and installed six new mills. New plant in operation March 18, 1912.

West Penn Steel Co.—Added three stands of hot rolls and two stands of cold rolls for making steel sheets, giving company ten stands of hot and ten stands of cold rolls. Installed second Mesta pickling machine.

Apollo Steel Co.—Building a six-mill sheet plant at Apollo, Pa.

Trumbull Steel Co.—Building eight tin plate mills.

De Forest Sheet & Tin Plate Co.—Installed electrically driven cold roll train, consisting of five cold rolled mills; one jobbing mill, with roughing mill, pinions, furnaces, etc.; one continuous pair furnace and one continuous sheet annealing furnace with capacity of 120 tons daily; new galvanizing department with six galvanizing pots, pickling department, etc.

Impervious Sheet Steel Co.—Formed last fall and is building plant at Rochester, Pa.

Miscellaneous Construction

Carbon Steel Co.—Completed installation of a 500-ton steam hydraulic press and installing 300 x 70-foot overhead crane runway with crane and magnet for handling raw material; a 500-horsepower Rust boiler and a Newton milling machine. Contemplate the erection of a universal mill building with overhead crane runway.

La Belle Iron Works. — Increasing boiler capacity 1,000 horsepower; installing feed-water heating and filtration plant and new department for handling sheet and plate mill scrap, with bundle press and other necessary machinery.

Republic Iron & Steel Co.—A 1,000-ton by-product coke oven plant. Field construction not yet begun and will not be completed until late in 1913.

Jones & Laughlin Steel Co.—Constructing 240 rectangular coke ovens at Woodlawn, Pa.

Cambria Steel Co.—One 6,000-kilowatt turbo generator, with additional steam plant, condensers, etc.; two electric traveling cranes in stock house; electric haulage system in minges; 32 nail machines; new machine shop and equipment for heavy reels for reeling chain rod and heavy rods; completion of wood-working shop for composite steel and wood cars; electric welder for car parts; electric transfer cars for inter-shop handling of car parts, and a new car paint shed.

Youngstown Sheet & Tube Co.—Made additions to fence department, wire drawing department, galvanizing department, nail department and warehouse.

Union Steel Casting Co.—Installed a 25-ton acid open-hearth steel furnace in plant No. 2.

Steady Progress on the Cuyuna

The Cuyuna range ended its second season as a shipper with an outgo of 350,000 tons, double that of 1911, and next year an increase to 1,000,0000 tons is predicted. Many properties are under exploration and at several tracts development work is being actually prosecuted. The range is proving of greater value than was predicted by some mining men who inspected the field in its earliest days, and it is the general concession that the discoveries of the last two years presage a bright future for the district. One of several prospective shippers for next season is the Pennington mine, in Section 10, T. 46, R. 29, 1 mile west of Crosby. The Soo Line has transported practically all of the ore shipped to date from the Cuyuna and is preparing to handle a much larger annual tonnage, but commencing with next year it will share the business with the Northern Pacific railway. The latter is extending tracks to various properties, one of these being the Barrows mine of M. A. Hanna & Co. At the Wisconsin Central dock at Ashland the last season, the Soo Line handled 1,018,487 tons of ore. Repairs costing $35,000 are to be made at this dock this winter.

Opens Boston Office.—The Union Drawn Steel Co., of Beaver Falls, Pa., announces the establishment of an office at 95 Milk street, Boston, in charge of K. W. Moynes, district sales manager. During the last ten years, Mr. Moynes has been in the company's New York office, as assistant to Thomas Towne, who is now general manager of sales. The territory within the jurisdiction of the Boston office will be comprised of the states of Maine, New Hampshire, Rhode Island and Massachusetts east of the Connecticut river, excepting Springfield and towns in the immediate vicinity and Millers Falls, which, with the remainder of New England, will be covered by the New York office as heretofore.

Southern Pig Iron Steadily Advanced in Price

And the Year Proved Fairly Satisfactory, Although There Were Some Disappointing Features—Bright Prospects for 1913

By Stanley G Backman

A REVIEW of the pig iron market in the Cincinnati territory during the past year shows fairly satisfactory conditions and very encouraging prospects. There was a gradual and general advance of prices, beginning early in the year and continuing, until in December quotations made by many sellers on both southern and southern Ohio grades were $4 above those of January, 1912. There was, however, one reversal in each market, that in the south coming in the last week in November, and the one in southern Ohio beginning about the middle of May and extending through July.

The advances during the year were the result of the natural trend of the markets in surrounding cities and of conditions in and around Cincinnati rather than of concentrated efforts of the furnaces. These conditions were of such a character as positively to eliminate all chances of the market remaining unchanged. Throughout the entire year, there was a decided shortage of railroad equipment, and shipments in some cases were seriously delayed. This had a tendency to bring out occasional spot markets, and also to warn melters to cover better for their future requirements, both of which are conducive to better prices. Then, also, the shortage of equipment and labor in the coke fields brought about a rise in the price of coke, especially during the last six months, that in some instances reached the abnormal stage, and since this meant an increase in the cost of the production of pig iron, quotations on the latter were necessarily advanced. A third reason is that stocks in furnace yards were constantly being reduced. This was especially true in the south, where in Alabama alone, there were 156,000 tons less piled by the makers in December than in January. This was one of the best features in regard to the strength of the market, and for better prices next year. Production was constantly kept up at the same time that the stocks were being reduced, which showed a consumption larger than the production. Most of the iron, also, that was bought, was melted and was not held for speculative purposes. The activity of the foundries in the immediate Cincinnati territory during the year, however, was not wholly satisfactory. During the first six months, their average melt amounted to about 50 or 60 per cent of their capacity, and at no time were they melting up to their full capacity. Foundries in nearby cities, however, were generally much busier in proportion, and, in a great measure, made up for the melt that was lacking in Cincinnati. Prices at the close of the year are shown in the accompanying table.

MAXIMUM AND MINIMUM PRICES AT THE CLOSE OF THE YEAR

BIRMINGHAM BASIS

	Spot shipment.	First Quarter.	Sec. Quarter.
Southern No. 2 foundry	$13.50 to 14.00	$14.00 to 14.50	$14.00 to 14.50
Southern No. 3 foundry	13.00 to 13.50	13.50 to 14.00	13.50 to 14.00
Southern No. 4 foundry	12.75 to 13.25	13.25 to 13.50	13.25 to 13.75
Southern gray forge	12.50 to 13.00	13.00 to 13.50	13.00 to 13.50
Mottled	12.50 to 13.00	12.75 to 13.50	12.75 to 13.50

IRONTON BASIS

	Spot shipment.	First Quarter.	Sec. Quarter.
Northern No. 2 foundry	$16.50 to 17.00	$17.00	$17.00
Northern No. 3 foundry	16.00 to 16.50	16.50	16.50
Northern No. 4 foundry	15.75 to 16.25	16.25	16.25

The southern market was chiefly characterized during the entire year by the extreme wide range of prices between the different furnaces, being more than a dollar in some instances, and at no time were they combined in an effort either to advance prices or to keep them at a fixed level. The lower priced furnace iron was usually to be found in Tennessee, but some Alabama stacks would sometimes follow the custom of selling a fairly large tonnage at the minimum quotation, and then withdraw from the market. On the other hand, there were certain furnaces in Tennessee which were never below the Alabama prices, but it can safely be stated that as a general rule, Birmingham irons, taken as a whole, sold for more during the year than did those made in Tennessee. There was considerable underbidding of the market at different times, but this was mostly done by certain groups in both states. This practice usually had a bad effect upon the market, for as soon as sales of this kind became generally known, buyers would try to obtain more iron at this figure, and prices would be weakened accordingly. Southern iron always sold higher in Birmingham direct than in Cincinnati, due to the fact that in the latter city the Tennessee makes as well as the southern Ohio and northern Ohio brands, and in some cases, even valley iron, were brought into competition with it, while in Birmingham the only competition met with was between the furnaces themselves.

Furnace Stocks Reduced

Stocks in furnace yards in the state of Alabama were constantly decreased during the year. On Jan. 1, 1912, there were 230,000 tons piled by the furnaces, while on the first of December, only 74,000 tons remained, making a total reduction of 156,000 tons for the year, not including the month of December. Of the remaining 74,000 tons, 44,000 tons were foundry iron, 27,000 tons warrant iron, and 3,000 tons basic iron. This was one of the strong features of the market, as production was constantly kept up, but it must also be taken into consideration that the territory around Birmingham has developed to a large extent within the past few years, and there was constantly a strong demand from this source.

The southern market experienced 16 distinct advances during the past year, and one temporary set-back. The advances came at the following dates: The first week in January; the last week in March; the first week in April; the second week in April; the first week in May; the second week in May; the first week in July; the first week in August; the third week in August; the fourth week in August; the first week in September; the second week in September; the fourth week in September; the first week in October; the second week in October, and the third week in November. The one reversal came about the last week in November, or the first week in December. It was caused by

several resale agencies suddenly placing a large quantity of resale iron upon the market at $13.50, Birmingham basis, including brands from both Tennessee and Alabama, in order to clear it all up before the first of the year. In some cases, also, furnaces which had made sales at low prices and still had deliveries to make on them, were anxious to have the tonnage off their books, and forced the iron upon those who had contracted for it. These buyers in turn, then, if they were of the speculative class, placed it upon the open market at $13.50, Birmingham, which was an advance over what they had paid for it. One Birmingham furnace, also, suddenly offered some of its iron for spot shipment at $13.50, which was the lowest at which furnace iron had sold in this state for several months.

One Good Buying Movement

This market had but one good buying movement, which began during the first part of August, and extended into the first part of September. Within one week during this period, fully 30,000 tons of southern iron were sold in this territory alone, while a large amount went to surrounding districts. It was occasioned by large buyers covering for their last quarter and first half requirements, and also because of the fact that several furnaces in both states were offering first class iron at rather low prices. In about two weeks, however, or as soon as a large proportion of the buyers had contracted, the situation began to slow down again, until within about a month it again lapsed into the inactive state in actual new business, which was characteristic of both the southern and northern markets during most of the year. The contracts previously placed, though, generally kept the dealers busy forwarding the iron to those who had bought it.

Stocks in Tennessee were not reduced in all cases, and in one or two instances furnaces piled their own iron rather than sell it at the prices then prevailing. They accordingly offered it at a low price during the last few months of the year, thereby holding the minimum quotation to a low level, but which was a larger profit proportionally to them, than the furnaces experienced who sold most of their output earlier in the year at a much lower figure, and then held at higher quotations during the latter part in order to attempt to counterbalance this.

Southern Ohio Iron

The southern Ohio furnaces began the year at $13, Ironton, for southern Ohio No. 2 foundry iron, and finished at $17, Ironton, having advanced $4.00 during the year, as was the exact case with southern iron. In this market, there were 11 advances during the year, which came as follows: The middle of March; the last of July and the first of August, when prices regained their former level, after a decided slump; the middle of August; the latter part of August; the second week in September; the third week in September; the fourth week in September; the first week in October; the second week in October; the fourth week in October, and the third week in November. This summation shows that prices advanced much more rapidly during the last half than the first half, undergoing practically only one advance during the whole of the former period.

The one slump came during the last of May and the first of June, and it was not until about the first of August that prices were substantially put upon their former basis again. When the slump began, southern Ohio No. 2 foundry iron was selling at $13.50, Ironton. During the latter part of May and the first of June it was lowered to $13, Ironton, on some makes as the minimum quotation, but came back to $13.25, Ironton, two weeks later. During the last week in July, it was again put upon the former basis of $13.50, Ironton, and continued more or less strong during the remainder of the year. This setback was caused by the fact that at that time, one, and possibly two, of the larger producers in that territory began to undersell the market, and took large tonnages at reduced figures. When this became known, the low selling price soon became the minimum quotation. Some of the furnaces, though, refused to reduce, and remained practically out of the market during this period, but occasionally placed orders at $13.50, Ironton, at the same time that the iron was being sold by others at $13, Ironton. Resale iron, as was the case in the south, played an important part during the year in keeping prices down, as there was always some to be had in varying amounts at prices slightly lower than most furnace quotations.

Another, and almost unlooked-for drawback was experienced also, when a couple of northern Ohio furnaces, which used their lower cost of production to good advantage, came down several times during the year, and took some of the most desirable business and larger tonnages at low prices. This was done more after northern and southern Ohio prices began to advance. When prices were low, the northern furnaces, even with their low cost of production, brought about by advantages of securing ore, could not afford to underbid the Cincinnati market, as the higher freight rates to Cincinnati more than counterbalanced this in comparison with the profit that could be made on the business at the price of iron at that time. As soon as prices began to go up, however, the territory over which they could operate at a profit in view of the circumstances stated above, began to extend until it reached Cincinnati.

MINIMUM PRICES OF SOUTHERN NO. 2 AND GRAY FORGE, AND NORTHERN NO. 2

	Southern No. 2, Cinci.	Southern gray forge, Cinci.	North'n No. 2, Cinci.
January	$13.25	$12.50	$14.20
February	13.25	12.50	14.20
March	13.31	12.50	14.45
April	13.75	12.50	14.70
May	14.20	12.85	14.60
June	14.25	13.00	14.33
July	14.50	13.50	14.45
August	14.90	13.90	14.95
September	15.75	14.75	15.83
October	16.70	15.70	17.30
November	17.00	16.19	17.83
December	16.75	15.75	18.20

Prospects are Good

The Cincinnati market, taken as a whole, cannot be said to be extremely satisfactory for the entire year, nor on the other hand can it be said to be a complete disappointment. It was satisfactory from the standpoint that prices were gradually advanced, but it is a question whether or not they advanced to as high a level as they should have in comparison with quotations in other districts. The furnaces were extremely independent in their actions toward one another, which accounts in a large measure for the wide range in prices that existed from time to time. The buying movements were probably a disappointment. To have only one or possibly two good buying movements during the whole year cannot be said to be up to expectations. This was counter-balanced, to a certain extent, however, by the fact that most of the furnaces, by hard work, managed to contract for enough business to keep production going at full capacity, and to forward shipments even at a greater rate than railroads could supply equipment to handle. Stocks in most yards were also constantly reduced, but these two last statements must probably be answered from the standpoint that the south is developing at a fast rate in regard to the consumption of pig iron, and that both the southern and southern Ohio irons are beginning to reach territories in all four directions heretofore uninvaded by either.

The outlook for next year is a great deal brighter than it was at this time last year, and unless unforseen reverses are experienced, prices should remain strong, and perhaps gain in strength, and a better buying and selling movement spring up during the first half of 1913.

Eastern Market Review

(Continued from page 5)

freely and advanced from 50 cents to $1. During August, September and October, heavy buying continued and prices steadily mounted. Buying of foundry iron was heavy in September and October and large lots of standard mill forge were booked in October and November at higher prices. An interesting incident of the market was the appearance in November of the Pennsylvania Steel Co. as a buyer of basic to recoup shortages in its own make. This company took 5,000 tons of prompt basic at $18, delivered Steelton. The price was lower than most makers cared to quote and was established by the Bethlehem Steel Co. offering a surplus lot. This latter company, early in the year, had freely sold foundry, forge and basic grades in accordance with its announcement of the previous October that it was able to offer round blocks of merchant iron from its output. In the last half, however, when the consumption of its own works had reached maximum proportions, it withdrew as an active seller. Its reappearance in the sale to the Pennsylvania Steel Co. was, therefore, a surprise. It is not expected, however, that the Bethlehem Steel Co. will have much surplus iron for sale under prevailing conditions. In fact, it was a buyer of a round block of low phosphorus metal for next year's delivery.

Advance in Pig Iron

The net advance in eastern pig iron in the year past represented about $4 in basic, $3.25 to $3.50 in foundry grades and $3.50 in standard forge. Low phosphorus was in great demand throughout the year, especially during the last three quarters, when the supply did not seem equal to consumptive needs. Standard low phosphorus advanced more than $5 a ton in 1912 or from $19.25, Philadelphia, in January, to $24.50, Philadelphia, in December. Eastern makers had fully 100,000 tons in orders upon their books for this grade at the year's end, and some producers, notably in the Lebanon district, were entirely out of the market. Some of the iron under sale was for all of 1913 delivery. Delaware river cast iron pipe makers were large buyers of forge and low grade iron during the year. The cast iron pipe industry was unusually active and makers booked heavily. This fact was reflected in their pig iron purchases, which were larger than for several years. The range in pipe forge in the year was about $14.50 to $17.75, delivered along the Delaware river. Buffalo makers have continued heavy sellers of metal for New England delivery, their lower costs enabling them, generally, to overcome the advantage of about 50 cents in freight with eastern Pennsylvania furnaces. In January, 1912, Buffalo makers held No. 2X at from $12.75 to $13, furnace, or practically $15.25 to $15.50, delivered New England. In December, Buffalo furnace prices ranged from $17.50 to $18 for No. 2X, or $20 to $20.50, New England. At the close of 1912, the eastern market was generally quiet and stationary, but showed no weakness, as makers were all in strong positions on bookings which in eastern Pennsylvania were fully ten times the aggregate stocks.

Eastern Furnace Operations

A careful compilation of the furnaces in blast in the eastern Pennsylvania and surrounding districts at the opening of the new year shows 24 strictly merchant stacks in operation and 34 idle. Two of the latter were on the point of blowing in and ten others were inactive, and are not likely to ever resume. Shortages of coke and labor were holding some furnaces in the idle class which operators were desirous of putting in commission. It is estimated that probably 70 per cent of the serviceable merchant capacity of the east, figured by output, was in operation in December. A year previous, as stated, operations were not over 50 per cent. The activities of steel works groups were more extensive relatively, as 22 out of 27 stacks, or fully 80 to 85 per cent, were blowing. One idle furnace, Maryland Steel, was undergoing rebuilding. Stocks of iron in eastern furnace yards, including merchant and steel works stacks, had been reduced to 100,000 to 150,000 tons, an accumulation which, considering the extent of the operations, is extremely scant. These stocks here shrunk steadily over the year from several times this amount 12 months earlier. Eastern merchant furnaces are now carrying an absolute minimum of stocked iron.

At the close of 1912 the following blast furnaces in eastern and central Pennsylvania and in tributary producing districts were in operation:

Lehigh valley:—Two Crane, Macungie, two Hokendauqua, Emaus, Alburtis, one Hellertown, Carbon, five Bethlehem, two Palmerton; total, 16 in blast, including nine merchant and seven steel works furnaces; 10 stacks idle, including three inactive, of which nine are merchant and one steel works stacks.

Schuylkill valley:—Two Warwick, one Brooke, two Swede, Sheridan, two Worth, Topton, Temple; total, 10 in blast, including four merchant and six steel works furnaces; seven idle, including one inactive, of which six are merchant and one steel works furnaces. Robesonia and Leesport are about to resume.

Lebanon district:—Four Lackawanna Iron & Steel, four Steelton, two Lebanon, one Paxton; total, 11 in blast, including five merchant and six steel works; eight idle, including four inactive, of which six are merchant and two steel works furnaces.

On tidewater:—Delaware River, total, one merchant stack in blast; none out.

New Jersey:—Oxford, one merchant stack in blast; eight stacks out, all merchant, of which one is inactive.

Maryland:—Three Maryland Steel; total, three steel works stacks in blast; one steel works stack idle.

Central Pennsylvania: — Colonial, Everett, Marshall, Saxton; total, four merchant stacks in blast; five stacks idle, all merchant.

Summary:—Twenty-four merchant stacks in blast, 34 idle, including 10 inactive stacks, with four stacks about to resume; 22 steel works stacks in blast; five idle, including one rebuilding.

The Virginia Market

Conditions in the Virginia district steadily improved over the year. Prices rose in that period almost $4 a ton, most of which came in the last nine months. The Virginia Iron Coal & Coke Co., the largest Virginia producer, took the lead in these advances. At the year's close, No. 2X Virginia was well established at $16, furnace, for first quarter, though the largest Virginia producer in November announced that it was completely out of the market on this one grade up to July 1, 1913. Its schedule remained unchanged on the other grades. Other Virginia producers were quoting similarly.

The recovery and expansion of the Virginia market in the year are well illustrated by the fact that in that period, a large stock of iron representing an eloquent reminder of the broken boom of 1907 and one of the largest single merchant blocks in the country, was offered and readily absorbed. This iron had been piled by the Virginia Iron, Coal & Coke Co. in 1907, and had been variously estimated at from 150,000 to 175,000 tons of different grades. After having been carried for practically five years,

it was transferred to consumers largely in the heavy buying movement of the third quarter without disturbing the market. At the year's close, this metal was going forth rapidly to the trade against these orders. The great bulk of the stocks of iron on Virginia furnace banks throughout the year was made up by this single block. On Jan. 1, 1912, total stocks in Virginia territory were about 205,000 tons and total orders about 70,000 tons. At the beginning of 1913, the stocks with all active producers apart from the Virginia company were only a bare 5,000 tons and the large stock had been dwindled to approximately 100,000 tons, all of which was under sale and this was being moved at the rate of 10,000 to 15,000 a month. Total orders of all makers were practically double the tonnage of the year before.

At the close of 1912, six Virginia merchant furnaces, or about 50 per cent of the serviceable capacity, were blowing. These were Dora, Crozer, Pulaski, one Low Moor, Buena Vista and Iron Gate, while Princess was about to go in. One new stack, Oriskany, was building.

Scrap Market

The old material market in the east began the year at a low ebb with No. 1 heavy melting steel about $12.25, No. 1 railroad wrought $15.25, and heavy cast $12.50, all delivered eastern Pennsylvania. In the reduced demand of the early months, consequent of the light operations of eastern consumers, the market further sagged and the low point was reached in February and March. From that time on, the advance was steady and the high point was reached in October with No. 1 heavy steel commanding $15.50 to $16, delivered, No. 1 railroad wrought $17.25 to $17.50, delivered, and heavy cast, $14.50 to $15, delivered. Around election time, the market weakened considerably. Steel dropped 75 cents to $1 a ton to about $15, delivered. No. 1 railroad wrought $1 to $16.25 to $16.50, delivered, while heavy cast about held its own. At the year's close, the market was rather listless and soft, as consumers had large stocks. Fundamentally, however, the conditions of consumption were such that this state of the market was believed to be only temporary.

Heavy Fabricated Tonnage

From all indications, the total tonnage of fabricated steel placed in this country in 1912 will exceed 2,000,000 tons, making it the largest year in bookings in the history of the steel industry. The other large years in the fabricated trade were 1906 and 1911, but neither of these exceeded the 2,000,000-ton mark. The production of fabricated steel in the year was considerably less than the bookings. Because of the great difficulty in getting sufficient supplies of plain material, many of the shops were unable to maintain full capacity operations, although they had the order books to justify them. This condition became pronounced during the last quarter of the year. As an example, the American Bridge Co. in the eastern district booked about 350,000 tons in the year and produced about 200,000 tons, though it had a shop capacity of 250,000 tons. Provided the two other divisions of the leading fabricator did proportionately as well, which is quite probable, the total bookings of the company were at least 700,000 to 800,000 tons.

As usual, Greater New York produced an immense tonnage of lettings which was fully up to the 300,000-ton mark that has been set by recent years as the normal stage for the metropolis. Subway construction furnished about 50,000 tons of new lettings in the year, all of which went to the American Bridge Co. At the year's close, there were in sight for subway and elevated railroad extensions in New York City, from 250,000 to 300,000 tons additional, none of which have yet been let. The Brooklyn Rapid Transit Co. put out inquiries for 150,000 tons of structural material and 25,000 tons of rails for elevated railroad construction, deliveries to be spread over three years, but action upon this requirement awaits the signing of operating contracts by the municipal authorities covering the city-built sections of new rapid transit lines. The Interborough Rapid Transit Co. is expected to put out about an equal requirement when this formality is also taken with respect to the lines awarded to it. Other leading fabricated contracts placed in the eastern district during the year were 40,000 for the remaining portion of the Hell Gate bridge, to the McClintic-Marshall Construction Co.; 30,000 tons for a large building to replace the destroyed Equitable building, 12,000 tons for the Adams Express Co. building, 10,000 tons for the Western Union building, 15,000 tons for the New York Edison Co. power plant, 12,000 tons for the Biltmore hotel, all in New York City and all awarded to the American Bridge Co. Milliken Bros., Inc., took about 20,000 tons for transmission towers for the Pacific coast.

Fabricated prices started at a low ebb early in the year, dropping below $40 a ton, delivered, in the first few months and then rose steadily, in sympathy with the advanced market in plain material. At the year's close they ranged from $48 to $50 a ton, delivered, for heavy work, representing an advance of about $10 a ton in the year. Leading fabricators expressed the opinion that the rise had not been as large as warranted by the changed conditions.

Equipment Buying Large

Equipment buying by the railroads in 1912 was on a very large scale. In fact, many of the steam systems had fallen so far behind in their rolling stock replacements that when the wave of industrial prosperity and heavy crops became assured, there was a rush with orders to car builders that fairly choked the available capacity. Furthermore, car builders found great difficulty in getting sufficient supplies from the overcrowded steel mills to fill their orders and this combination of conditions forced some roads ordering cars at the close of the year to await for deliveries in the fall of 1913. Prices of steel cars rose about one-third from the depressed levels of the last quarter of 1911. It is estimated that fully 175,000 to 200,000 freight and passenger cars were ordered by the railroads in 1912, or more than the high record of 175,000 cars built in 1910. In 1911, the orders reached about 135,000. Up to August 1, 1912, about 95,000 cars had been placed. October was a very heavy buying month and fully 40,000 cars went upon builders' books in that period, some for delivery as far ahead as next fall. The New York Central lines bought about 20,000 cars in the year; the Pennsylvania system 15,000 to 20,000 and practically every leading system contracted for equipment in equal proportion. Locomotive orders, it is estimated, will exceed 4,000, which represents a heavy year.

Activity in Rails

In rail production, 1912 has been a good, but not a record year. The output of the mills will probably be around 3,500,000 tons for the year. This compares with 2,822,790 tons in 1910, and the high record mark of 3,977,887 tons in 1906. During the first half of 1912, the mills produced according to official statistics, 1,466,000 tons. These operations over the second half were considerably increased,

for producers then profited materially from the heavy buying movement for 1913 delivery, which began to take form early in August, or at an unusually early date. In this heavy buying were included a number of supplemental purchases for deliveries before Jan. 1, so that as a result makers generally ran their mills to highest capacity over the last quarter. The rail buying for 1913 delivery has been extraordinarily heavy and it was estimated on high authority that makers entered the new year with fully 3,000,000 tons booked and many of them were unable to promise any large additional tonnages before mid-year. These heavy bookings at the start of the new year furnish strong expectations that a new high record of rail production will be established in the United States in 1913, which implies that more than 4,000,000 tons will be produced. As examples of the heavy contracts closed by leading systems for next year, the New York Central Lines purchased on initial contract from 165,000 to 170,000 tons, compared with an initial contract of about 115,000 tons in 1911. The Pennsylvania lines up to the year's close had contracted for a total of 183,800 tons, which represents the heaviest purchase for renewals made by this system in the past 10 years. The highest previous purchase was in 1906, when 163,797 tons were used, according to official records. The Baltimore & Ohio, the St. Paul, the Harriman and other systems ordered tonnages considerably in excess of their requirements of the past several years. Canadian roads found much difficulty in getting deliveries from their domestic mills, which were also heavily sold and some attractive tonnages were placed on this side of the border. Unusually heavy rail breakages during the winter months, especially in the severe climates of the northwest, led to renewed discussion of rail quality, which resulted in a conference of manufacturers and railroad managers being called at New York in February by Chairman Gary, of the United States Steel Corporation, as chairman of a joint committee that had been created several years previously to consider this subject. After several conferences and much discussion, the entire matter was referred to a sub-committee consisting of three rail manufacturers and three railroad executives to make a full report with recommendations. As far as known, this committee has not yet presented its conclusions in report form.

The great revival of American merchant ship building along the eastern coast which came into prominence in 1911, was continued unabated throughout 1912, and the end of that year finds the ways of some of the yards still filled with work for a year or more ahead. With the formal opening of the Panama canal only nine months away, or on Oct. 1, 1913, steamship interests are bending their efforts to get many new craft into service for the institution of a number of new lines of transportation between the Atlantic seaboard and the west coast of South America, Hawaii, San Francisco and other Pacific ports. The action of congress in denying free tolls to railroad-owned ships caused some large projects of vessel construction to be abandoned. One of these was that of the Pacific Mail Steamship Co., controlled by the Union Pacific railroad, which had perfected plans for a fleet of large size freight and passenger boats for a new Atlantic-Pacific coast line.

Active Ship Building Year

One of the most significant vessel contracts placed in the year was that awarded to the Wm. Cramp Sons Ship & Engine Building Co. by W. R. Grace & Co., an English shipping firm, for the building of four large freight and passenger vessels of about 10,000 tons burden each. These are the first vessels to be built in the United States for this English shipping house and the first English-owned boats to fly the American flag. The privilege of free tolls through the Panama canal to American-built boats was the impelling influence for the placing of the contract on this side, although the British ship yards have been heavily filled with work. These boats will form a new line between New York and the west coast of South America. Another important contract placed with the Maryland Steel Co. calls for three additional vessels for the American-Hawaiian Steamship Co., which will be sister craft of the five boats ordered by this steamship interest in 1911, making a total fleet of eight new vessels.

Export Trade Increases

With such a heavy home demand, the necessity has not been generally felt the past year by American steel makers to push their products vigorously into foreign markets, although generally they are giving more and more serious thought to the extensions of export trade. At one time in the year, there was talk of the formation of a co-operative export company by the independent steel manufacturers to be modeled after that of the United States Steel Products Co., but nothing tangible developed of the movement. In February, the Jones & Laughlin Steel Products Co. was organized to look after the export business of that important steel company. While the domestic steel trade of the United States has been so active as to cause most makers to ignore foreign trading opportunities, the worldwide prosperity of the iron and steel industry, nevertheless, has directed numerous inquiries to this side for European shipment. Usually in those cases where export trade was taken to satisfy shortages abroad, the prices realized were quite as attractive as those prevailing in this country. Early in the year, some eastern Pennsylvania plate makers made shipments to Scotland ship yards and the Republic Iron & Steel Co. made a sale of 10,000 tons of southern pig iron for shipment to Hull, England, for the American Radiator Co. Some other round tonnages of southern pig iron were sold for delivery at the ports of Genoa, Italy, and Trieste, Austria. High ocean freights which have prevailed in the year have been a factor discouraging the acceptance of European iron and steel orders by American makers. Very heavy orders in rails, car and structural materials, pig iron and other products were taken on this side from Canadian consumers. The Canadian Car & Foundry Co. was a large buyer, taking 20,000 tons of pig iron, 20,000 tons of billets and a round tonnage of plates on one occasion. Mexico and the South American republics have been liberal buyers.

Because of its well organized and permanent activities in the export field, the United States Steel Products Co. has continued to gain trade in all parts of the world and its bookings in 1912 will reach about 2,500,000 tons, or an increase of about 250,000 tons over 1911, which was hitherto its record year. Total exports of American iron and steel products in 1912 are estimated at about 2,800,000 tons, or the highest in history. This compares with 2,187,000 tons in 1911. The re-export American tin plate trade, which up to two years ago was supplied largely by Welsh makers, now seems to be safely held by American mills. During 1912, the imports of foreign tin plate to this country were practically negligible, while American makers not only captured the re-export business of such large buyers as the Standard Oil Co., but shipped plate freely to South America, Australia and other neutral markets. The canning industry, with the consequent tin plate consumption,

is expanding rapidly in South America. Total exports of American tin plate in 1912 were about 100,000 tons, or 2,000,000 boxes. Among the important export orders taken by American steel makers during the past year were 35,000 tons of line pipe for the Roumanian government.

The Bethlehem Steel Co. received large orders for armor plate and ordnance for Italy, Greece and Chili.

Steel Corporation Bookings

A very impressive reflection of the great expanse in iron and steel demand in the year is shown by the increase in the unfilled tonnage awaiting manufacture upon the books of the United States Steel Corporation during the year, as announced by the monthly statements. During the year, the Steel Corporation's accumulated business increased approximately 3,000,000 tons, or practically 60 per cent, against productive operations which expanded from 70 to 75 per cent in January, 1912, to 90 to 95 per cent at the close of the 12 months period. Every one of the calendar months excepting March, reported up to December, showed a substantial increase from the preceding month. The December figures, which will not be announced until Jan. 10, are expected to maintain this record. The highest monthly increase was realized in October and reached 1,042,874 tons despite a steel productive rate during that month, which was the highest in the history of the leading interest. The unfilled tonnage of the Steel Corporation at the end of 1912 represented approximately 4,600,000 tons above the stage at the end of June, 1911, when the expanse in orders began to clearly manifest itself.

The official monthly record of the unfilled tonnage of the Steel Corporation in 1912 is as follows:

Date.	Total tonnage.	Change tonnage.
Dec. 31, 1912.....	8,000,000*	150,000+
Nov. 30, 1912.....	7,852 883	258 502+
Oct. 31, 1912.....	7,594,381	1,042,874+
Sep. 30, 1912.....	6,551,507	388 132+
Aug. 31, 1912.....	6,163,375	206,296+
July 31, 1912.....	5,957,079	149,773+
June 30, 1912.....	5,807,346	56,363+
May 31, 1912.....	5,750 983	86,983+
Apr. 30, 1912.....	5,664,885	360,044+
Mar. 31, 1912.....	5,304,841	149,359—
Feb. 29, 1912.....	5,454,200	74,479+
Jan. 31, 1912.....	5 379,721	294 960+
Dec. 31, 1911.....	5,084,761	942,806+

*Estimated.

The year has seen the scope and influence of the American Iron and Steel Institute so extended and elaborated that it has become a strong factor as an organized representation of the American iron and steel industry and its diversified ramifications. The membership in the year was extended to over 825 officers of companies and others interested in manufacturing enterprises directly or indirectly associated with the iron and steel industry. Very successful meetings were held by the Institute in New York in the spring, and Pittsburgh in the fall. It is the intention to continue this plan of semi-annual sessions, the spring meeting to be always held in New York.

An important consolidation in the eastern district finally effected was the acquirement of the Eastern Steel Co., Pottstown, Pa., consisting of two stacks and one held under lease. It is expected that eventually steel making and finishing capacity will be built in close proximity to the blast furnace and a well-rounded works established. The Eastern Steel Co. controls large iron ore deposits in Cuba, which have never been actively developed. The Steel Corporation announced in January that it had acquired the plant of the Baltimore Bridge Co., Baltimore, for warehouse and export purposes.

The Central Iron & Steel Co., Harrisburg, Pa., was placed in the hands of a receiver Feb. 6, upon the defaulting of its bonded interest and was still being operated under the direction of the courts at the close of the year. The company is making substantial progress and promises to work out of its embarrassment in the near future. Coincident with this action, the West End Furnace Co., Roanoke, Va., and some smaller plants which were controlled by interests associated with the Central Iron & Steel Co., also went into a receivership.

New Construction

Blast Furnaces

(Non-Merchant)

No. 2 Worth, Coatesville, Pa., 21 x 85 feet completed and blown in Dec. 4; capacity, 450 tons daily.

No. 3 Swede, Swedeland, Pa., 21 x 85 feet completed and put in operation; will work alternately with Nos. 1 or 2; capacity, 450 tons daily.

One Maryland Steel, Sparrows Point, Md., being rebuilt.

(Merchant)

Northern, Port Henry, N. Y., 17 x 80 feet, erected to replace former furnace and blown in; capacity, 225 tons daily.

Nos. 3 and 4 Susquehanna, Buffalo, each 20 x 80 feet, completed and blown in. No. 3 on Feb. 6; No. 4 on Aug. 1; daily capacity, 350 tons each.

Oriskany, Lynchburg, Va., 16 x 80 feet, under construction and will be completed in March; capacity, 150 tons daily.

Princess, Glen Wilton, Va., rebuilt after accident, another stove added and capacity increased to about 100 tons daily.

Warwick, alternate stack, Pottstown, Pa., 20 x 80 feet, completed and put in operation; capacity, 400 tons daily.

Steel Works

Six 75-ton open-hearth furnaces under construction at Saucon plant of Bethlehem Steel Co., South Bethlehem, Pa., capacity, about 300,000 tons annually; first three furnaces to be completed early in second quarter. Additional hot metal mixing equipment being installed.

Three 40-ton open-hearth furnaces under construction at Roebling, N. J., plant of John A. Roebling Sons Co.; capacity, about 80,000 tons annually.

Two 60-ton basic open-hearth furnaces and a 600-ton hot metal mixer installed to No. 1 plant and put in operation by Lackawanna Steel Co., Buffalo; capacity about 75,000 tons annually; new gas producer plant of eight 10-foot Morgan producers, and one 165-ton and one 75-ton ladle Morgan crane also installed; two 200-ton Talbot continuous open-hearth furnaces under construction in No. 2 plant with annual capacity about 240,000 tons when operated on the duplex process; plant will be equipped with two 165-ton and one 75-ton Morgan ladle cranes; appropriations made for four additional 60-ton open-hearth furnaces of stationary type to No. 2 plant; annual capacity about 150,000 tons.

Rolling Mills

An 84-inch plate mill for rolling light gages being installed at Ivy Rock, Pa., plant of Alan Wood Iron & Steel Co.; capacity, about 50,000 tons annually.

Mill for rolling copper-clad sheets and strips installed by Duplex Metals Co., Chester, Pa.

Additional finishing mills in contemplation at plant Bethlehem Steel Co., South Bethlehem, Pa., the character of which has not been announced.

Miscellaneous

First unit of 75 ovens of by-product coke plant Lehigh Coke Co., South Bethlehem, Pa., completed and put in operation, in capacity about 100,000

tons monthly; plant to eventually comprise 300 ovens.

Bolt, nut and spike plant for manufacturing track bolts and spikes completed and put in operation by Lackawanna Steel Co., Buffalo; occupies new building, 138 x 200 feet; annual capacity spikes, bolts and nuts about 28,000 tons. Calcining plant for burning of lime consisting of three 8-foot by 125-foot rotary kilns and auxiliary equipment under construction by company in connection with extensions of No. 2 open-hearth plant.

Equipment Dismantled

Two blast furnace stacks, Poughkeepsie Iron Co., Poughkeepsie, N. Y.; capacity, 75,000 tons annually, purchased and dismantled for scrap.

Structural mills, Passaic Steel Co., Paterson, N. J., being gradually dismantled and equipment sold; fabricating plant in operation and being extended.

A Satisfactory Machinery Year

Both the railroads and manufacturing interests had accumulated extensive needs for machinery through the policy of expense curtailment pursued during the previous years, and with favoring conditions a good volume of business was expected. The one probable obstacle to the realization of this condition was the national election. Buying gained momentum, however, almost from the beginning of the year and fear of political disturbances waned in converse degree to the rising optimism of the users of machine shop equipment. The improvement was most noticeable among the manufacturing industries, though transportation companies placed a much larger aggregate of orders in the New York market than they did in 1911. Manufacturers of electrical equipment were conspicuous buyers. The General Electric Co. closed on several lists ranging from $10,000 to $60,000 in value in this market. The Morrow Mfg. Co., manufacturer of automobile accessories, placed orders for approximately $100,000. A large amount of trade originated among the railroad equipment builders, including a list aggregating about $200,000 closed for by the Lima Locomotive Works, Lima, O. Among the large individual lists bought by the railroad companies were the following: The Morgan's Louisiana & Texas Railroad & Steamship Co., about $125,000; the Chesapeake & Ohio, $25,000; the New York, New Haven & Hartford, $80,000; the Norfolk & Western, $40,000; the Harriman lines, $1,000,000; the Pennsylvania railroad, $250,000, and the Virginia railway, $40,000. In December, the Boston & Maine railroad distributed specifications for the equipment required at the new Bellerica, Mass., shops, aggregating about $500,000 in value. The Brazilian government placed orders for machinery amounting to over $100,000 through a New York export house.

At the close of the year, there was a good general demand for machinery and builders are well supplied with orders. Prices are higher than the preceding year.

STEEL IS SCARCE

On the Pacific Coast—Domestic Pig Iron Excludes Foreign.

Tacoma, Wash., Dec. 28.—Local manufacturers have been experiencing great difficulty in getting steel enough to fill the orders they have on hand. The Seattle Construction & Dry Dock Co. reports that its receipts of steel are very much less than its requirements and that it is troubled with getting shipments enough to even construct the steel ships under contract. J. V. Paterson, president and general manager, reports that he has even been refused quotations because of the lack of material. The steel companies declare that they must catch up with their previous orders before booking additional ones. Rush orders will not be considered at all and any order given must be subject to delayed delivery. Steel is bringing about $2.65 per hundred weight from the store.

Pig iron deliveries are about normal. The market for foreign iron is stagnant because of the price made on domestic. Balfour, Guthrie & Co. report that the best price they can make on Glengarnock pig iron is $29. H. J. Brenner, manager of the grain and pig iron departments, said that the next shipment of iron would have to sell at a still higher price owing to the condition of the foreign markets. The same grade is bringing $30 in London today, he said. The company has 250 tons in storage here and will not import more until the market revives.

Domestic pig iron from Birmingham is bringing about $26 and a fair demand for it is felt at this price. Considerable building is going on in the northwest and the foundries and erecting shops are working full time. One new building for which plans are being drawn in Portland will need 1,500 tons of steel.

Indications point to a greater activity in the building line in the northwest after Jan. 1. Railroads are planning extensions in terminal facilities. The Northern Pacific railroad will double-track its main line from Tacoma through the Cascade mountains next spring. The cost of the improvement or the number of miles of double track construction has not been definitely decided by the officials.

The Seattle Construction & Dry Dock Co. has its new 12,000-ton floating dry dock about completed. This dock will be the largest on the Pacific coast and is being built to care for the increased shipping that the Panama canal will bring to the coast. On Jan. 15, the dry dock will be finished and the city of Seattle plans a fitting celebration. This same company is building a 242-foot steel suction dredge for the United States government to operate principally at Coos Bay, Oregon. The dredge is being built so that it can be used in rought sea weather.

D. C. Jackling, of Salt Lake City, Utah, has ordered a handsome sea-going yacht from the Seattle Construction & Dry Dock Co. It will be of steel construction and will be operated around the world.

To handle the increasing traffic between Tacoma and Seattle, the Inland Navigation Co. has let a contract to the Seattle Construction & Dry Dock Co. for a 19-knot steel vessel which will be the fastest commercial steamer on Puget Sound when it is completed. It will be finished next spring to take up the run when the heavy summer traffic begins. The company has also let a contract for a small steel cargo vessel to ply between Sound points.

The Milwaukee Terminal Co. has ordered a sea-going steel tug from the Seattle Construction & Dry Dock Co. It will cost $100,000.

Decides Case

The Interstate Commerce Commission, on Dec. 20, disposed of the Detroit reconsigning case which had agitated the coal and industrial world of that city for two years. It held that the proposed charge of $2 for the reconsigning privilege used within the switching limit of Detroit would be unreasonable, unless the carriers notify consignees of the arrival of the cars consigned to them on the tracks at Toledo.

Construction of Blast Furnaces Proceeds Slowly

Rate of Increase of Capacity in Earlier Years Not Being Maintained —Commercial Changes Viewed in Connection With Pig Iron Making

By B E V Luty

IN SIX successive annual review numbers of THE IRON TRADE REVIEW, the writer has presented a review of blast furnace building, the chief purpose being to present as accurate a statement as can be compassed of the actual commercial pig iron capacity of the country. There is always need for such a statement because the trade is ever possessed with a desire to know whether the market is going to go up or down and light can always be thrown upon that interesting and important question by comparing the current production and demand with the existing capacity. The commercial capacity is, however, quite a different thing from the theoretical or nominal capacity, which, of course, takes into account merely the physical existence of furnaces. These may or may not be able to make pig iron without loss. It is stating an elementary principle to observe that they must be able to secure their raw materials and labor on the one hand, and to dispose of their product on the other hand, at prices in such relation that no loss is incurred. The commercial capacity is thus entirely distinct, and indeed widely separated, from the theoretical or nominal capacity. What, indeed, is the commercial capacity at a given time; upon what premises shall it be computed or estimated?

When open market conditions prevail, it may even be urged that the commercial capacity of the country is simply the amount of pig iron that is being made. If more can really be made, why are not the idle furnaces blown in? Those who desire, for business reasons, to know what is the commercial capacity of the country at any given time, really wish to know how much more pig iron could be made should the market advance a couple of notches or so. If pig iron production has been running along at a certain gait for a twelvemonth, with prices fluctuating only between the limits of $14 or $15, one does not want to know what output would be forced, should an unlimited demand suddenly appear at $25. Such a matter would hardly have even an "academic" interest. One would, however, very much like to know whether much idle capacity would come into blast, should a price of $17 be freely offered. If much capacity were waiting to come in at that figure, then it would be difficult for the market to advance; if little, then a $2 advance might quickly occur.

Basis of Previous Estimates

These reviews for six years past have sought to establish approximately the blast furnace capacity of the country under market conditions somewhat similar to those which prevailed in 1905-6-7, and the basis used was the fact that from July 1, 1906, to July 1, 1907, substantially the entire productive capacity of the country was at work. The average price of pig iron during that period was well above $20 a ton at northern furnaces. By presenting a carefully kept record of the new furnaces completed, the additional capacity could be shown and thus the total existing capacity shown for any date.

Conditions have changed so radically of late that this method is not as useful as it was. Not only has it come about that sharp advances in pig iron prices to the neighborhood of $20 or higher are not expected, but it has also occurred that the supplies of raw materials, and particularly coke, have become so limited, relative to the total nominal capacity of the blast furnaces that they cannot all be expected to get into blast when an apparently profitable price is offered for pig iron. Witness, for instance, the movement in 1912. Pig iron advanced an average of $4 per ton, but Connellsville coke advanced by an amount equal to $2 per ton of pig iron, and Lake Superior ore by an amount equal to $1 per ton of pig iron. That leaves only $1 advance for the furnaceman, and since at the bottom, before the $4 rise, the conditions entailed an actual loss to many furnaces, it is obvious that a $4 advance does not necessarily bring much capacity into the commercially profitable class. If $4 does not, can it reasonably be argued that $8 would certainly do it? With the record of 1912 before us, we cannot say as we once could say with confidence, that the commercial blast furnace capacity of the country is thus and so. The governing elements have come to include important matters outside of the physical existence of furnaces.

New Furnaces in 1912

The following strictly new furnaces were added to the list in 1912:

Buffalo - Susquehanna Nos. 3 and 4	2
Madeline No. 2 (Inland)	1
Iroquois, Chicago, C and D	2
Worth Bros. No. 2	1
Northern, Port Henry, N. Y.	1
Total furnaces	7

According to some views the above list would not be regarded complete. Two furnaces were blown in during 1912 which were named in our review of a year ago as having been completed in 1911, but not blown in, Rover No. 2 and Josephine No. 2. One or two furnaces have been built as alternate stacks, and others have been built to replace old stacks.

The annual capacity represented in the seven furnaces named above is approximately 1,000,000 tons a year.

In the last annual review, a complete list of the 73 new furnaces completed during the seven years, 1906 to 1911 inclusive, was given, the name and location of the furnace being stated, together with the size and annual capacity. It is not necessary to repeat the list again. The new capacity represented may be summarized with the addition of 1912, as follows:

	Annual capacity.
1905	1,292,000
1906	1,135,000
1907	2,065,000
1908	1,188,000
1909	1,930,000
1910	1,794,000
1911	565,000
1912	1,000,000
Total	10,969,000

On the basis of the actual production from the middle of 1906 to the middle of 1907, with allowance for the new furnaces since then, the present capacity would be 34,400,000 gross

tons per annum. We are now, however, far from our base of supplies in the matter of information. Many furnaces operating six years ago have since been improved, even rebuilt entirely, while on the other hand many furnaces then operating are now many dollars a ton away from operating, some of them, indeed, got so far away that their owners have dismantled them. It remains the fact, however, that under something like normal commercial conditions, the actual capacity lies between the limits of 33,000,000 and 35,000,000 tons.

Capacity Under Present Conditions

So great changes have occurred in commercial conditions that the question of blast furnace capacity can be studied from entirely new angles. Observe that with an excellent demand for both pig iron and finished steel products, resulting in the operating merchant furnaces becoming sold up for several months ahead, and the steel mills having on their books actual specifications for three months of operation at the existing rate, with contracts for a still longer period, the increase in pig iron production has almost stopped, although the rate, according to the monthly returns to THE IRON TRADE REVIEW show that the current rate of output of all pig iron, including charcoal iron, is only a trifle in excess of 32,000,000 tons a year. In the past twelvemonth, there has been an advance of fully $4 a ton in pig iron and of more than $6 a net ton in finished steel products.

The important question, as observed at the outset, is how much more capacity would be placed in the reckoning by a further advance in prices of the product, say, for instance, an advance of $2 a ton. Observing that with an advance of $4 a ton in pig iron the coke needed to make a ton of iron has advanced $2 and the ore required has advanced $1, it is quite obvious that an additional advance of $2 in pig iron might not increase the spread at all between the raw materials and finished product of the blast furnace. Connellsville coke for prompt shipment does not sell at about $4 a ton, as it practically did throughout December, if there is more coke waiting to be sold to furnaces as they go into blast.

Mr. Swank's Presentment

A very interesting presentment to the literature on the blast furnace capacity of the country was made by James M. Swank in *The Bulletin* for Dec. 1, 1912. Mr. Swank found that the actual productive rate on July 1, 1912, was approximately 30,250,000 tons. Then he found that from July 1 to Nov. 30, 64 furnaces, idle on July 1, and one furnace completed after that date, blew in, involving 5,218,000 tons of annual capacity, and making with the 30,250,000 tons, a total of 35,468,000 tons. Additional furnaces to the number of 32, with 1,986,000 tons of annual capacity, he was advised were likely to get into blast in December or later, but not later than the summer of 1913. That would swell the total to 37,454,000 tons.

There were still 101 furnaces in existence, and not included in any of the above reckonings. Of these, 58 furnaces, with 3,673,000 tons annual capacity, were active at one time or another between Jan. 1, 1909, and June 30, 1912, although none was active on July 1, 1912. Adding these to the previous count would make 41,127,000 tons. Finally, the furnaces in existence and not already catalogued amounted to 43, with 1,766,000 tons annual capacity, last active in 1908 or in some earlier year. Adding them to the reckoning makes 42,893,000 tons.

Here we have all gradations, from 30,250,000 tons actually being made on July 1, 1912, up to 42,893,000 tons, comprising that active capacity, plus the theoretical capacity of all the furnaces which were idle on that date.

At a glance, it would look as though our previously expressed idea that the blast furnace capacity of the country, under something like ordinary commercial conditions, is between 33,000,000 and 35,000,000 tons, is altogether too low in the light of Mr. Swank's presentment. Experience, however, has shown that statements involving the addition of rated capacities of individual furnaces are always excessive. In rating a single furnace, for a year's output, naturally no allowance is made for relining and accidents, yet with 100 furnaces there are always some out, and at best the rating is likely to be on the high side. This argument can be reinforced by a practical citation from Mr. Swank's presentment itself, however, showing that very considerable allowances must be made. He found that pig iron was being produced at 30,250,000 tons a year on July 1, 1912, and that from July 1, 1912, to Nov. 30, 1912, furnaces with 5,218,000 tons annual capacity were blown in. Adding these, we have 35,468,000 tons. Was that the actual rate of production on Nov. 30, 1912? Not at all. The monthly returns of THE IRON TRADE REVIEW (which the official semi-annual statistics always confirm very closely) show that the rate on Nov. 30, 1912, was only equivalent to about 32,000,000 tons. While 5,218,000 tons of capacity went in during the five months, about 3,500,000 tons, or precisely two-thirds as much, must have gone out. In active times, there are idle furnaces, but they are the insurance for those operating.

It is very fortunate indeed that the trade has had the benefit of Mr. Swank's most admirable compilations. They have invariably been made with such care as to be absolutely conclusive upon the points which they purported to cover. Mr. Swank has absolutely divested his presentments from editorial observations or attempts to discuss. He has given the trade the bare figures, realizing that the compiler would depreciate his valuable work by mixing opinion with it, and recognizing that the trade is fully competent to supply its own opinions.

Prospective Increases in Capacity

New construction is at a low ebb in the blast furnace industry. Possibly the most important new construction involves the pair of Steel Corporation furnaces near Duluth, and the pair of the Pittsburgh Steel Co. at Monessen. There are only a few others. Altogether there is not enough to begin to maintain the pace at which the blast furnace capacity expanded in the dozen years from 1899 to 1910, inclusive. Indeed, so small has been the new construction in the past two years that the industry is now altogether undersized, unless it be claimed that demand stopped growing two or three years ago at the rate which it has maintained for half a century. In alternate decades production has more than doubled, and in the intermediate decades it has done somewhat less than double, making it that in periods of 20 years it has quadrupled. From 1866 to 1886 the production of pig iron was multiplied by about four and one-half; from 1886 to 1906 it was also multiplied by about four and one-half. Had the same proportionate rate of gain continued, the tonnage of 1912 would have been 40,000,000 tons, not the 30,000,000 tons actually produced in the year, nor the 32,000,000-ton rate which was attained in the three closing months, in which statement, coupled with the fact that relatively little new blast furnace construction is now in progress, and little also of coke oven erection, there is much food for thought.

Extending Foreign Trade

Continued from page 9

tribute the rising and very splendid set of commercial conditions under which the Germans work and as a result of which they have become so important a factor in supplying material to the South American republic.

"In addition to all the above, the Germans will supply material exactly as desired by the purchaser, while the American in general adopts the principle of submitting his goods and then endeavoring to persuade the prospective purchaser that these goods are what the latter desires. If the purchaser cannot see the matter in the same light, the American does not endeavor to accommodate him by manufacturing, supplying and above all, shipping the goods as desired to meet the needs of the people and to conform to the conditions existing in these countries and required by the custom authorities.

"Why, to illustrate, I have known where an agent of an American manufacturer of collars received a large order for this class of goods. Because, however, the purchaser desired the collars marked differently from that done in the United States, in centimeters, the American manufacturer refused to fulfill the contract.

* * * *

"The success of the Germans is due to their exporting methods, as I have outlined them—their knowledge of the language and their studies of the wants of their customers. As a result of their thorough efforts in these directions, the Germans have been extremely successful in South American trade.

"North American people have never been colonizers, so we have this disadvantage at the outset. In no part of South America do you find any extensive American colonies. So we can look for no assistance from our kind of people excepting that which the diplomatic and consular service affords. Practically all the increased export business that has resulted for this country in recent years can be attributed to the efficient management of our state department. Our consular and diplomatic service, I am happy to say, has ceased to be political and is now conducted, as well known, under the merit system, the applicant for a position being compelled to pass a stringent examination and after being accepted is obliged to attend a diplomatic school, at which he receives thorough and efficient instruction in his duties. The rewards, as in any business concern, depend entirely upon the successful performance of duties. Most all the good work that has been accomplished in recent years to improve the condition of American foreign trading, I attribute to the new set of conditions introduced by our state department in rehabilitating the service rendered by the diplomatic and consular service. Too much credit cannot be given to the excellent work accomplished by this service. We hear much of late of the 'dollar diplomacy' which in our country is new. It is not new except to us, as all governments which have successfully gained foreign trade have practiced it for years. This is particularly true of Germany and England.

"It has been said that we are not understood by the people of South America. It is true. The reason is that we have neglected them. We have practically no lines of communication between the United States and the South American republics and as a result of the case by which he can travel from any of his countries to the European countries, the South American has given his trade to the latter. It is a surprising fact that any of the steamship lines plying between South America and Europe, particularly English and German lines, will sell first class passage to the United States by way of Europe at but £1, or $4.85, more than from South America to Europe. The object is to direct the trade to European countries as well as the traveling public which has desires of going to the United States.

"Recently the Lamport & Holt line has placed in direct service, between the United States and South America, a new and very excellent ship, the Vestis, which offers facilities second to none. It will be noted that this is an English steamship firm, which, realizing that the trade between the United States and the South American republics is bound to grow, has taken this effective step towards supplying direct communication between Rio Janeiro, Buenos Ayres and New York."

* * * *

"Would the re-establishment of a comparable merchant marine for the United States aid us to win the trade of South America?" I inquired. Mr. Johnston struck the mahogany desk with his clenched fist as he drove home his answer.

"Nothing would go so far toward establishing a thorough understanding between the people of North and South America as the rehabilitation of the American merchant marine, and I speak with confidence when I say, such an advent would be welcomed by each and every one of the South American republics," he said. "The president of the republic of Chili, in speaking to me personally, on this subject, expressed the desire to do everything in his power to aid the establishment of a line of ships between the United States and Chili by way of the Panama canal. Chili is wide awake and quick to see the advantage that would accrue to both countries from this action, and I say this advisedly. We in the United States need their mineral wealth and they need our manufactured products. Practically all of our goods which they receive today are carried in foreign bottoms and, as is well known, the freight rate from the United States to South America, by reason of the ownership of the means of transportation, is very materially higher than the rate on the same material from Europe. This will never be corrected until our materials are transported from this country in lines either owned and controlled in the United States or owned and controlled jointly by companies organized with capital from the United States and South American countries."

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"Would you regard South America as neutral ground where the efforts at general exportation by American iron and steel makers would most likely bring satisfactory results?" I asked.

"South America is neutral ground for trade for iron and steel makers of the United States except that we are not so well prepared, generally speaking, as other countries for handling this business, due to the peculiar conditions I have hitherto referred to at length. The opportunities for selling industrial material are today in my opinion greater in the Spanish-speaking countries of South America than any other countries to which the United States could export its products of whatever character.

"In the present development of South America, practically everything that is manufactured of iron and steel can be sold there, from the fact that notwithstanding the great mineral resources, practically nothing has been done toward the production of iron and steel materials. All the rails in the ever-expanding railroad systems of the continent, all the locomotives and all the cars, both passenger and freight, are imported. In general, most of the passenger cars—at least a large percentage of them—come

from the United States. But it is equally true that most of the freight cars, as well as most of the locomotives are at present supplied by German and English firms.

"There is a great demand for structural steel material in South America. In Valparaiso and Santiago, Chili, in Buenos Ayres and La Platte, Argentine Republic, in Montevideo, Uraguay, in Santo and Rio Janeiro, and in other leading cities, buildings are being constructed entirely of structural steel or reinforced concrete. A considerable part of this structural steel, as well as of the rails which formerly were all supplied from Europe, is now being furnished by the United States. Most all of the smaller steel products, such as steel bars, sheets, etc., come from Europe. Corrugated sheets particularly are in great demand. Due to the uniform and to a great part, dry climatic conditions, corrugated sheets can be used to great advantage in rapid building construction.

"In the case of armament, the United States had supplied practically none to South America prior to the award made by the Argentine Republic several years ago to the Fore River Ship Building Co. and to the New York Ship Building Co., for the construction of the two greatest dreadnoughts ever built, the ordnance, material, guns, armor, projectiles, etc., for which are being supplied by the Bethlehem company; and until the recent order given the Bethlehem company for large coast defense guns for the republic of Chili. This latter contract amounts to about $2,000,000 of ordnance and includes the furnishing of the guns, mounts, projectiles, in fact, the installation complete, including the fire control system as used in this country.

"The competition for the contract was entered into by all the large ordnance making firms of the world, including Krupp, of Germany, the Armstrong, the Vickers and the Coventry ordnance works, of Great Britain, and the Schneider Co., of Creusot, France. Notwithstanding the fact that all the former contracts of this kind had been awarded to the English, German or French companies, the Chilean government authorities decided after four months' deliberation, that the coast defense system of the United States, as equipped by the guns from our works, were superior to any in the world. The Bethlehem guns were chosen for this reason and against the fact that ours was not the lowest bid.

"The well-informed Chilean authorities—and this is said advisedly, for the Chilean officers are extremely well-informed—stated that the coast defenses of the United States were undoubtedly superior to any in the world today, and for that reason our system of fire control and the the American type of guns and ammunition were adopted. As evidencing the up-to-date spirit of the Chilean and his aptitude in grasping the trend of world-wide events, the government there has started an artillery school patterned after the school at Fortress Monroe, Va. Admiral Sir Jorge Montt, chief of the Chilean navy, that grand man who has recently been decorated by King George with the Cross of St. Michael and of St. George, had no hesitancy in saying that our system of artillery instruction and our training school of this order were the peers of any in the world."

* * * *

"It has been said, Mr. Johnston, that the iron ore deposits of South America are of great estimated extent and that they sooner or later will become an important source of supply for this country. What do you think of it?"

"The probabilities are that the iron ore supplies of the United States in the future, unless some new fields are discovered, will come from South America," said the Bethlehem steelmaker, rising to give added force to his words. "There are larger known iron ore deposits in South America today than in any other field accessible to this country and these, as stated, are almost entirely undeveloped. Upon inquiring as to the cost of transporting ore from South America to the United States by way of English and German lines, I received a quotation on rates, which, due to the control of the means of transportation by these countries, was 50 per cent higher to the United States than to any European country. This again points to the importance of the re-establishment of the merchant marine of the United States. The resources of South America, speaking especially of minerals, have as yet scarcely been scratched; most of these still require to be developed. It is my belief that, as a result of the wisdom displayed in building the Panama canal, very extensive business connections pertaining to the marketing of their mineral wealth will result between the neighboring republics of South America and their sister republic of the north."

CHARCOAL PIG IRON

Smaller Output Largely Due to Decreased Wood Supply.

A study of the statistics of the production of charcoal pig iron in the United States during the past five or six years would afford plenty of food for thought to a man interested in the tendencies exhibited by the iron and steel industry in this country. Although the amount of charcoal pig iron produced has fluctuated widely with varying market conditions, it is a significant fact that the ratio of the charcoal iron production to the total production has steadily declined during the past six years and is still on the down grade. As a result, the charcoal industry is now only about two-thirds as important (as relates to mere tonnage output figures) as it was half a decade ago. The figures from which these deductions are made, taken from the statistics of the American Iron and Steel Association, are as follows:

Year.	Pig iron Production. tons.	Charcoal pig iron made. tons.	Ratio of charcoal to total production. per cent.
1906.....	25,307,191	433,007	1.71
1907.....	25,781,361	437,397	1.69
1908.....	15,936,018	249,146	1.56
1909.....	25,795,471	376,303	1.46
1910.....	27,303,567	396,507	1.45
1911.....	23,649,547	278,676	1.18

The decadence of the charcoal pig iron industry is due to a number of causes, among which the two principal ones are the reduction in the wood supply, resulting in higher prices for charcoal, and economies brought about in the manufacture of coke iron. The only thing apparently that has saved the charcoal industry from utter extinction, has been the establishment of wood distillation plants in connection with charcoal furnaces. These plants make their charcoal in closed retorts, and recover valuable by-products, including acetate of lime, methyl alcohol, tar, gas, etc. But the investment required in a plant of this kind is approximately three or four times that necessary simply for a charcoal furnace of 75 tons daily capacity. Many charcoal furnace owners have been unable to raise the necessary capital or have lacked sufficient enterprise to go into new lines of production, and have, therefore, dropped out of the race. In the south at present, it is said, there are only two charcoal furnaces active.

As the industry is now aligned, it is operated mainly for the production of alcohol and calcium acetate, pig iron being a by-product. Consequently the price of charcoal pig iron has shown some peculiar fluctuations during the last two years.

High Prices Enjoyed by the Coke Producers

Output for Year Very Large, But Was Somewhat Curtailed by Shortage of Labor—Interesting Features

By C F Williams

THE fondest dreams of coke producers were more than realized in 1912. By far the best prices in years were enjoyed. As high as $3.50 was obtained for contract 48-hour coke at the ovens, and furnace coke sold as high as $4.25, ovens, for immediate delivery.

Ovens in the upper and lower Connellsville regions made excellent records for production. From weekly reports of the Connellsville *Courier* it is estimated production this year will exceed 20,000,000 tons. In 1908 ovens produced, 10,700,022 tons; in 1909, 17,785,832 tons; 18,689,722 tons in 1910, and 16,334,174 tons in 1911. Figures indicate that production this year exceeds that of any year since 1906.

If it had not been for the acute labor shortage, it is probable that the 1912 tonnage would have exceeded 23,000,000. The scarcity of labor in the regions, combined with the unusually heavy demand, are responsible for the high prices that prevailed the latter part of 1912.

TABLE SHOWING QUOTATIONS ON COKE FOR PROMPT SHIPMENT AT OVENS IN THE CONNELLSVILLE REGIONS.

	—Furnace—			—Foundry—		
	1910.	1911.	1912.	1910.	1911.	1912.
Jan.	$2.48	$1.41	$1.84	$3.03	$1.97	$2.05
Feb.	2.33	1.44	1.85	2.95	1.95	2.22
March	2.10	1.58	2.06	2.77	2.00	2.65
April	1.70	1.55	2.44	2.54	1.99	2.75
May	1.60	1.44	2.57	2.29	1.90	2.62
June	1.63	1.43	2.17	2.21	1.77	2.56
July	1.63	1.42	2.25	2.10	1.80	2.46
August	1.62	1.51	2.25	2.17	1.85	2.60
Sept.	1.60	1.50	2.31	2.13	1.85	2.67
Oct.	1.59	1.50	3.22	2.09	1.86	3.35
Nov.	1.49	1.50	3.82	2.01	1.89	4.41
Dec.	1.45	1.64	3.93	2.00	1.90	4.50
Aver.	1.77	1.48	2.55	2.36	1.89	2.90

Consumers paid higher prices for coke than at any time for a half decade. Accompanying tables indicate that prompt furnace coke averaged $1.77, at the ovens, in 1910; $1.48, ovens, in 1911, and $2.55, ovens in 1912. The 1912 average exceeds that of the preceding year by $1.07 a ton, and is $0.78 a ton above that of 1910. Prompt 72-hour coke in 1910 averaged $2.36, ovens; $1.89, ovens, in 1911, and $2.90, ovens, in 1912. The 1912 average is $1.01 above the 1911 average, and $0.54 above the average established in 1910.

Contract furnace coke, in 1912, averaged $2.35, ovens, and contract foundry coke averaged $2.80, ovens, during the same period. During the last 40 days of the year, it was impossible to obtain contract furnace coke at less than $3.25, ovens and foundry coke during that period was firmly held at about $4, ovens.

Despite the demand, ovens in the regions seemed unable to produce more than 400,000 tons of coke a week. Only 12 times previous to the week ending Dec. 28 was the 400,000 ton mark passed. Records indicate that this figure was exceeded by the weeks ending Jan. 20 and 27; March 16 and 30; April 6 and 27; May 4 and 11; Nov. 16, 23 and 30, and Dec. 21. The week ending April 6 was the banner week of the year; 415,464 tons were produced that week.

WEEKLY PRODUCTION IN THE UPPER AND LOWER CONNELLSVILLE REGIONS, FROM REPORTS COMPILED BY THE CONNELLSVILLE COURIER

Date.	Ovens.	In.	Out.	Production tons.
Jan. 6.....	38,805	28,093	10,712	322,906
Jan. 13.....	38,733	29,230	9,543	391,432
Jan. 20.....	39,063	30,424	8,639	407,185
Jan. 27.....	38 975	30,349	8,646	400,597
Feb. 3.....	38,995	30,487	8,508	360,153
Feb. 10.....	38 995	30,434	8,561	354,569
Feb. 17.....	38,995	30,592	8,403	393,664
Feb. 24.....	39,015	30,736	8,279	391,253
Mar. 2.....	39,015	30 947	8,068	396,010
Mar. 9.....	39,015	31,055	7,960	396,715
Mar. 16.....	39,015	31 883	7,132	408,237
Mar. 23.....	39,015	31,990	7,025	398,847
Mar. 30.....	38,767	32,140	6,627	413,141
April 6.....	38 767	32,238	6,529	415,464
Apr. 13.....	38,659	32,372	6,287	363,289
Apr. 20.....	38 659	32,345	6,314	396,320
Apr. 27.....	38,659	32,591	6,068	401,494
May 4.....	38,659	32,663	5,996	401,544
May 11.....	38,657	31 340	7,317	401,960
May 18.....	38,657	31,495	7,162	398,596
May 25.....	38,657	31 506	7,151	394,316
June 1.....	38,657	31,489	7,168	379,121
June 8.....	38,657	31,422	7,235	398,656
June 15.....	38 657	31,444	7,213	391,792
June 22.....	38,657	31,600	7,057	373,729
June 29.....	38 657	30,561	8,096	393,640
July 6.....	38,672	30,483	8,189	329,161
July 13.....	38,642	30,416	8,226	375,557
July 20.....	38,642	30 239	8,403	355,108
July 27.....	38,642	30,282	8,360	315,723
Aug. 3.....	38,728	30 347	8,381	379,157
Aug. 10.....	38,728	29,420	9,308	385,967
Aug. 17.....	38,728	29,648	9,080	374,101
Aug. 24.....	38 728	29,876	8,852	369,118
Aug. 31.....	38,728	30,015	8,713	371,915
Sept. 7.....	38 728	30,572	8,156	357,839
Sept. 14.....	38,728	30,700	8,028	372,781
Sept. 21.....	38,728	30,651	8 077	373,631
Sept. 28.....	38,728	30 735	7,993	382,627
Oct. 5.....	38 728	30,700	8,028	398,201
Oct. 12.....	38,728	32 326	6,402	397,507
Oct 19.....	38,748	32,334	6,414	399,449
Oct. 26.....	38,748	32,370	6,378	399,835
Nov. 2.....	38 843	32,514	6,329	397,253
Nov. 9.....	38,843	32,565	6,278	399,142
Nov. 16.....	38 843	32,600	6,243	400,618
Nov. 23.....	38,875	32,684	6,191	404,652
Nov. 30.....	38,875	32,691	6,184	400,111
Dec. 7.....	38,875	32,660	6,215	393,006
Dec. 14.....				389,064
Dec. 21.....				412,118
Dec. 28.....				**372,000
Total				20,058,941

**Estimated.

Consumers who obtained 1912 contract coke from $1.60 to $1.90, ovens, will pay from $2.25 to $3.25, ovens, for requirements during 1913. The Youngstown Sheet & Tube Co., Youngstown, O., paid $1.60, ovens, and slightly above, for 35,000 tons a month for 1912 shipment; this interest, early last fall, closed negotiations for 70,000 tons a month for 1913 delivery at $2.35 and $2.40, ovens, or approximately 75 cents above the price for the preceding year.

Corrigan, McKinney & Co., Cleveland, several months later, paid $3, ovens, for 60,000 tons for 1913 shipment, which indicates the rapid rise of the market the latter part of the year. The Canada Iron Corporation, Midland, Can., after scouring the market for a week or 10 days, closed negotiations early in November for 12,000 tons a month at slightly below $3.25, ovens. Another interesting purchase was that of the Wheeling Steel & Iron Co., Wheeling, W. Va., the latter part of November, for 30,000 tons a month for 1913 shipment at slightly above $3, ovens. The Pittsburgh-Westmoreland Coal & Coke Co. sold 120,000 tons of coke at about $3.25, ovens, to a Pittsburgh broker the latter part of November.

TABLE SHOWING AVERAGE MONTHLY MINIMUM PRICES CONNELLSVILLE FURNACE AND FOUNDRY COKE PER TON AT THE OVENS, FOR 1912

Month.	Prompt. Furnace.	Contr. Furnace.	Prompt. Foundry.	Contr. Foundry.
January	$1.84	$1.85	$2.05	$2.07
February	1.85	1.85	2.22	2.23
March	2.06	2.10	2.65	2.49
April	2.44	2.23	2.75	2.75
May	2.57	2.37	2.62	2.70
June	2.17	2.25	2.56	2.61
July	2.25	2.25	2.46	2.50
August	2.25	2.30	2.60	2.60
September	2.31	2.30	2.67	2.68
October	3.22	2.63	3.35	3.28
November	3.82	2.87	4.41	3.69
December	3.93	3.25	4.50	4.00
Average	2.55	2.35	2.90	2.80

One of the interesting features of the coke market this year was the alleged attempt upon the part of certain producers to obtain $2.50, ovens, for coke last summer and the subsequent informal investigation on the part of officials connected with the United States department of justice. This investigation, it is understood, has been dropped.

Average Monthly Prices of Iron and Steel Products, 1901-1912

Finished Products in Net Tons. Pig Iron and Billets in Gross Tons

1901

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$14.60	14.12	15.19	15.50	15.50	15.50	15.50	15.20	15.00	15.00	15.00	15.50
Gray Forge Cincinnati	$12.25	11.87	12.56	13.12	12.60	12.25	12.00	12.00	12.00	12.25	12.69	13.00
Plates Chicago	$31.00	30.00	32.40	34.40	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
Billets (Bess.) Pittsburgh	$19.75	19.75	20.81	24.12	21.20	24.44	24.25	24.40	24.12	26.80	28.25	27.62
Bessemer Pig Pittsburgh	$13.25	13.60	16.56	16.69	16.65	15.94	16.00	15.90	15.71	15.90	16.10	16.35
Beams Pittsburgh	$30.00	30.00	30.40	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00
Bar Iron Cleveland	$25.80	27.80	29.30	30.80	29.80	29.80	29.40	30.80	30.60	32.80	32.00	31.70
No. 2 Foundry Birmingham												

1902

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$15.80	16.75	18.62	19.75	21.75	22.50	23.40	24.66	27.15	27.15	26.90	25.40
Gray Forge Cincinnati	$13.75	13.75	15.25	16.00	17.05	18.93	20.00	21.50	21.50	20.60	18.87	18.00
Plates Chicago	$35.00	35.00	35.25	36.25	38.60	43.00	43.00	43.00	43.00	40.60	40.50	41.00
Billets (Bess.) Pittsburgh	$28.06	29.81	31.37	32.25	33.90	35.18	33.50	32.12	31.50	29.80	29.00	29.25
Bessemer Pig Pittsburgh	$16.70	16.93	17.56	18.37	20.95	21.25	22.00	21.75	21.75	21.95	22.25	22.12
Beams Pittsburgh	$32.00	32.00	34.00	37.00	40.00	45.00	45.00	47.00	45.00	43.00	42.00	40.00
Bar Iron Cleveland	$32.10	33.70	35.70	35.77	37.70	37.70	37.70	37.70	37.70	37.50	36.20	35.70
No. 2 Foundry Birmingham												

1903

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$25.00	24.00	24.00	23.00	21.70	20.50	18.50	17.50	16.85	15.90	14.50	14.30
Gray Forge Cincinnati	$20.50	20.75	19.35	19.20	17.70	16.50	14.60	13.50	13.25	12.30	10.95	10.75
Plates Chicago	$35.00	37.00	38.00	40.00	37.75	35.00	35.00	35.00	35.00	35.00	35.00	35.00
Billets (Bess.) Pittsburgh	$29.75	30.00	30.25	31.00	30.50	29.50	27.50	27.00	27.00	26.50	23.50	23.00
Bessemer Pig Pittsburgh	$22.35	22.35	22.00	21.60	20.00	19.85	19.00	17.85	16.35	15.85	15.25	14.35
Beams Pittsburgh	$35.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00
Bar Iron Cleveland	$32.00	37.00	37.00	36.00	35.00	33.75	22.00	30.00	29.00	28.00	26.00	25.50
No. 2 Foundry Birmingham												

1904

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$14.10	13.75	13.55	14.00	13.80	13.40	13.30	13.35	13.40	13.70	15.60	16.60
Gray Forge Cincinnati	$11.00	11.00	11.25	11.75	11.25	10.75	10.75	11.00	11.00	11.75	14.25	15.00
Plates Chicago	$35.30	35.30	35.30	35.30	35.30	35.30	35.30	35.30	29.30	29.30	29.30	30.10
Billets (Bess.) Pittsburgh	$23.00	23.00	23.00	23.00	22.00	21.50	21.00	20.00	19.50	19.50	21.00	21.00
Bessemer Pig Pittsburgh	$13.60	13.35	13.85	14.10	13.60	12.60	12.50	12.65	12.75	13.35	15.25	16.60
Beams Pittsburgh	$32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	28.00	28.00	28.00	30.00
Bar Iron Cleveland	$25.00	26.00	27.00	29.00	29.00	28.00	28.00	25.00	25.00	27.00	28.00	32.00
No. 2 Foundry Birmingham	$ 9.75	9.50	9.70	10.00	9.65	9.15	9.15	9.50	9 50	10 65	12,75	13 05

1905

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$17.50	17.50	17.50	17.50	17.25	16.60	16.15	16.35	16.50	17.55	18.90	19.50
Gray Forge Cincinnati	$15.25	15.20	15.00	15.20	14.81	13.85	12.28	13.00	13.00	13.88	15.35	15.75
Plates Chicago	$31.30	32.30	32.30	34.80	35.30	35.30	35.30	35.30	35.30	35.20	35.30	35.30
Billets (Bess.) Pittsburgh	$21.00	24.90	24.60	25.50	23.50	22.00	22.00	23.50	25.75	25.95	26.30	26.50
Bessemer Pig Pittsburgh	$16.85	16.45	16.35	16.30	16.20	15.65	15.00	15.40	15.90	16.50	17.70	18.10
Beams Pittsburgh	$30.00	31.00	32.00	32.00	32.00	32.00	32.00	32.00	34.00	34.00	34.00	34.00
Bar Iron Cleveland	$33.25	33.00	32.00	32.00	31.50	30.00	29.75	32.00	34.00	34.25	37.20	40.00
No. 2 Foundry Birmingham	$13.50	13 50	13 50	13.25	12.75	11.85	11 00	11 65	11.75	12.50	14.00	41.00

1906

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$19.25	19.25	19.00	18.75	18.50	18.10	18.30	18.90	19.75	21.50	26.50	27.00
Gray Forge Cincinnati	$15.75	15.05	14.85	14.75	14.75	14.65	14.55	15.40	16.50	17.50	21.70	22 00
Plates Chicago	$35.30	35.30	35.30	35.30	35.30	35 30	35.30	35.30	85.30	35.30	35.30	37.30
Billets (Bess.) Pittsburgh	$27.00	27.50	27.65	27.75	27.00	26.25	27.00	28.00	28.50	28.50	29.00	29.75
Bessemer Pig Pittsburgh	$17.32	17.29	17.26	17.25	17.24	17.38	17.57	17.98	18.44	20.06	21.96	22 75
Beams Pittsburgh	$34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00
Bar Iron Cleveland	$38.00	35.50	34.00	33.00	32.00	32.00	32.00	33.50	34.00	36.00	39.00	39.00
No. 2 Foundry Birmingham	$14.00	14 00	13 70	13 65	13 75	13 50	13 00	14 15	16 00	7 15	21 25	22 00

1907

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$26.00	26.50	26.75	27 50	27 40	26.50	25.40	24.50	23.60	22.60	20.60	19.00
Gray Forge Cincinnati	$22 60	22.50	22.10	21.50	21 90	21.35	20.55	19.95	18.85	18.45	17.35	15.50
Plates Chicago	$35.30	37 30	37.30	37.30	39.40	39.60	39.60	39.60	36.60	37.60	37.60	37.60
Billets (Bess.) Pittsburgh	$29.75	29.50	29.25	29.75	30.25	31.00	30.00	30.00	29.50	28.50	28.00	28.00
Bessemer Pig Pittsburgh	$22.92	22.78	22.85	22 16	24.10	24.10	23.30	22.90	22.90	22.80	20.60	19.90
Beams Pittsburgh	$34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.05	34.00
Bar Iron Cleveland	$39.00	36.50	36.00	36.00	35.00	34 00	34.00	33.00	33.00	32.50	31.00	31.00
No. 2 Foundry Birmingham	$23.00	23.00	22.75	22.00	21.40	21 25	20 50	19.80	18.12	17.65	16.00	14.91

1908

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$18.24	17.87	17.42	17.21	17 00	17 31	17 00	17 00	16 75	16 50	16.75	17 35
Gray Forge Cincinnati	$14.45	14.06	13.63	13.60	13.50	13 75	13 70	14 00	14 25	14.25	14 25	14 75
Plates Chicago	$37.60	37 60	37.60	37.60	37.60	36 60	35 60	35 60	35 60	35 60	35 60	35 60
Billets (Bess.) Pittsburgh	$28 00	28.00	28.00	28.00	28.00	26 50	25 00	25 00	25 00	25 00	25 00	25 00
Bessemer Pig Pittsburgh	$19.00	17.90	17.86	17.49	16.92	16 90	16 73	16 11	15 90	15.48	16 74	17 40
Beams Pittsburgh	$34.00	34.00	34.00	34.00	34.00	33 00	32 00	32 00	32 00	32 00	32.00	32.00
Bar Iron Cleveland	$28.80	27.00	28.00	28.40	30.00	29 00	29 00	29 00	29 00	29 00	29 00	29.00
No. 2 Foundry Birmingham	$12 80	12 50	12.12	11 90	11 50	12 00	11 60	12 06	12 50	12.50	12 50	13 00

1909

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$17.44	16.75	16.50	16.46	16.21	16 41	16 90	17.37	18 20	18.87	19.00	19 00
Gray Forge Cincinnati	$14.75	14.62	13.50	13 25	13.31	13.50	13 95	14 62	15 25	16.62	16 75	16.75
Plates Chicago	$35 60	34.10	29 60	28 60	28 95	28 60	30.60	31 60	32 80	33.60	35.60	35 60
Billets (Bess.) Pittsburgh	$25 00	23.50	23.00	22 00	22 50	23 00	24 00	25 00	26 00	26 50	27 50	27 50
Bessemer Pig Pittsburgh	$17.34	16.78	16 34	15.80	15 48	16 13	16 37	17.13	18 33	19.68	19.90	19.90
Beams Pittsburgh	$32 00	29 00	26 00	24.00	25 00	26 00	27 00	28 00	30 00	30.00	31.00	32 00
Bar Iron Cleveland	$29 00	28 75	26 20	25 25	25 00	24 20	29 25	30 00	30 00	30 00	32 00	32 00
No. 2 Foundry Birmingham	$13.00	12.70	11.75	11.00	11 00	11 31	12 30	13 00	14 00	14.50	14.50	14.00

1910

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.
No. 2 Foundry Chicago	$19 00	18.75	18.25	17 00	16.75	16 5	16 50	16.50	16.50	16 00	16.00	16.00
Gray Forge Cincinnati	$16.50	16.38	15.75	14.88	14.56	14 35	14 12	13.75	13.75	13.75	13.75	13.75
Plates Chicago	$35 60	35 60	34.60	33.60	33 60	32 60	31 60	31 60	31 60	31.60	30 60	30.60
Billets (Bess.) Pittsburgh	$27.87	27.50	27.50	27 00	26.12	25.50	25.00	25 00	24.50	23.38	23.00	23 00
Bessemer Pig Pittsburgh	$19.90	19.42	18 90	18.15	17.09	16.73	16.46	16.21	15.90	15.90	15.90	15.90
Beams Pittsburgh	$31.00	31 00	30.40	30.00	30 00	29.20	28.20	28.00	28.00	28.00	28.00	28.00
Bar Iron Cleveland	$33.00	33.00	33.00	32 50	31.00	30.10	28.00	28.00	28.00	28.00	27 80	27.00
No. 2 Foundry Birmingham	$14.00	13 88	13.00	12.12	11.81	11.60	11.38	11.00	11.00	11.00	11 00	11 00

1911

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$15.00	15.00	15.00	15 00	15.00	15.00	15.00	14 50	14 50	14.50	14.00	14.00
Gray Forge Cincinnati	$13 35	13.25	13 15	13.05	12.90	12.50	12.05	12 05	12.05	12.00	12.00	12.00
Plates Chicago	$31.60	31 60	31.60	30.60	30 60	30.60	13 60	29 60	29.60	26 60	25.00	25.00
Billets (Bess.) Pittsburgh	$23 00	23.00	23 00	23 00	23.00	21.00	21.00	21.00	21.00	20.00	19.70	19.25
Bessemer Pig Pittsburgh	$15.90	15.90	15 90	15 90	15.90	15.90	15.90	15.90	15.90	15.39	15.10	15.15
Beams Pittsburgh	$28.00	28.00	28 00	28.00	28.00	27 00	27.00	27.00	26.40	24.00	22.60	23.25
Bar Iron Cleveland	$27.00	27.00	27.00	26.75	26.20	24.75	24.00	25.00	24.75	24.00	24.00	24.00
No. 2 Foundry Birmingham	$11.00	11 00	11.00	11.00	10.75	10.25	10.00	10.05	10.10	10.00	9.75	10.00

1912

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 2 Foundry Chicago	$14.00	14.00	14.00	14.25	14.50	14.50	14.62	15.30	16.37	17.30	17.87	18.00
Gray Forge Cincinnati	$12.50	12.50	12.50	12.50	12.85	13.00	13.50	13.90	14.75	15.70	16.18	15.75
Plates Chicago	$26.00	25 76	25.90	27.55	28.60	28 60	29.60	30.40	31.35	32.60	33.60	33.60
Billets (Bess.) Pittsburgh	$20.00	20.00	19.88	20.00	21.10	21.88	22.25	22.40	23.75	25.70	26.75	27.00
Bessemer Pig Pittsburgh	$15.15	15.00	15.02	15.15	15.15	15.15	15.15	15.43	15.93	17.75	18.05	18.15
Beams Pittsburgh	$23.00	23.00	23.00	23.40	25.00	25.00	26.00	27.40	28.60	28.60	29.00	29.00
Bar Iron Cleveland	$24.00	23.50	23.50	24.00	24.40	25.25	27.00	27.25	29.00	30.20	31.00	31.00
No. 2 Foundry Birmingham	$10.00	10.00	10.06	10.50	10.95	11.00	11.25	11.65	12.50	13.45	13.75	13.50

Charts based on above prices are published as a supplement of today's issue.